POWER

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Reading vs. Filing

I KNOW and you know men who are addicted to the filing habit.

They are always on the lookout for something to file.

They have treatises and articles and descriptions and statistics and catalogs upon all sorts of subjects.

But they do not read them.

Their files are rich resources of special information, but their minds are often blank.

Far be it from me to disparage the intelligent filing of useful information. The idea that I seek to get over is that it is not the article that one files, but the one that he reads and takes into his thinking, that broadens his view, enlarges his knowledge and makes a bigger man of him.

It is little satisfaction, when a subject is under discussion, to be able to say: "Yes, I filed an article on that last week by some fellow whose name began with J."

It would be a lot more satisfaction to one and more edifying to the others if he could tell what Mr. J. said about it.

And probably if he had read the article attentively, he would have had some worth-while thoughts upon the subject himself or at least some intelligent questioning that might have led him to a better knowledge of the subject.

And it really takes so little time, once one gets the habit.

A page of *Power*, solid type, contains some 1,200 words. A very few minutes will enable one to absorb it, to make it a part of himself to think about, to talk about, to know.

The next time you are tempted to put aside an article "for future reference" unread, just try and see how short a time it will take you to read it and how much more good it will do in your head than in your filing cabinet.

F. R. Low

A Model Small Industrial Plant

ATTRACTIVE small plant, in which cleanliness is the watchword. Incidentally, remodeling the boiler room at a cost of $35,000 effected a saving of $20,670 a year.

THE accompanying photographs demonstrate what may be done in making a power plant neat and attractive and a pleasant place to work in. Too often the small industrial plant is dingy and unattractive. Open handling of coal and ash and slovenly methods of operation contribute to the disorder, and the results obtained are, as a rule, commensurate with the general appearance, although, of course, the original design of the plant and equipment has a bearing on both factors. The psychological effect works either way, and it is preferable to have it on the side of cleanliness and economy. At least this is the view held by the Froedtert Grain & Malting Company, of Milwaukee, present owners of the plant, which is called upon to operate twenty-four hours a day and seven days a week to meet the demands of two distinct branches of the business—the manufacture of malt and general grain handling and merchandising.

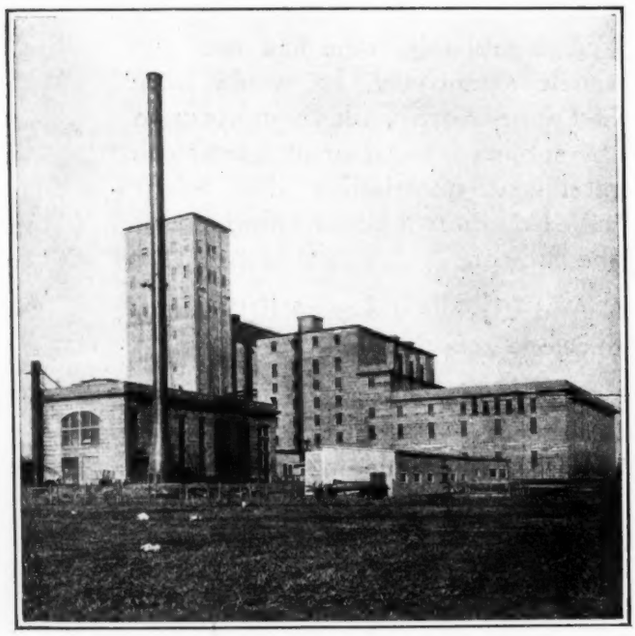


Fig. 1—Power plant in foreground

As the photographs do not picture adequately the color scheme, it may be well to point out that the building is of reinforced concrete throughout, beams, roof girders and all included. Engine and boiler rooms are of the same size, each 54x58 ft. and 40 ft. high to accommodate vertical boilers. In the engine room an 8-ft. wainscoting has a Tiffany finish, the walls above are painted green, while the floors, ceiling and pipe covering are finished in buff. As a pleasing contrast the machinery is painted an olive green with gold striping and the switchboard in black. A monitor roof and an abundance of glass in the side walls gives good lighting and ventilation.

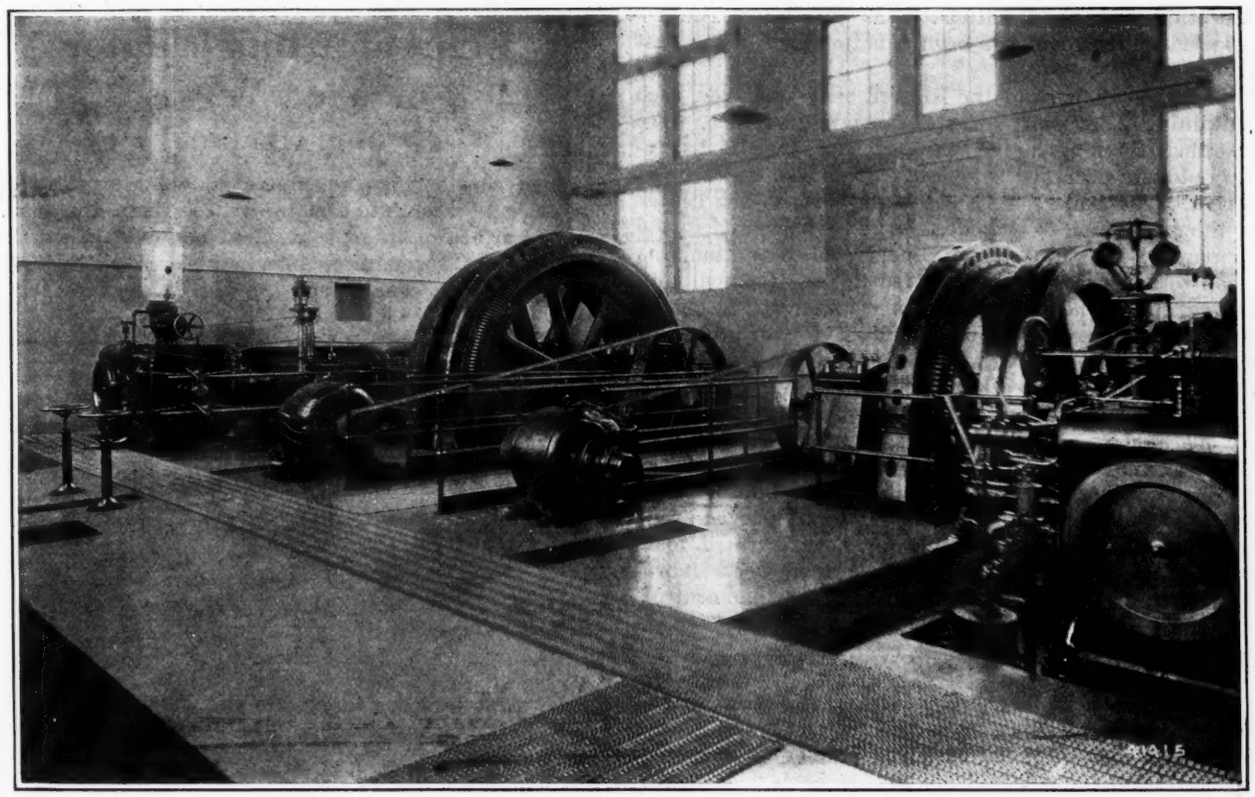
There are two main generating units, consisting of 440-volt three-phase 60-cycle generators, each with belted exciters, driven by heavy-duty Corliss engines, one rated at 400 kw. and the other at 600 kw. The smaller prime mover is 24x36-in., and the larger engine 28x42-in., the speeds being 120 and 100 r.p.m. respectively. The present-day load ranges from 200 to 400 kw. and the night load one-third less, averaging about 5,500 kw.-hr. per day of 24 hours. The main units are operated non-condensing, against a back pressure of 3 to 4 lb., to supply exhaust steam for drying purposes in the malt kiln, in which 45,000 sq.ft. of direct radiation is installed for drying alone and for heating the offices and the garage. The exhaust steam is utilized as far as it goes and is supplemented with live steam. As determined by numerous tests, the live steam required for the foregoing purpose, including the supply to the boiler feed and other pumps in the plant, averages about 42 per cent of the power steam. In other words, to put the steam generation on an equitable basis, the total equivalent boiler kilowatts is 42 per cent greater than the kilowatt output at the switchboard.

Old Equipment Unsatisfactory

During the early life of the plant all was not well in the boiler room. The plant was built in 1914, and the original equipment here consisted of three 2,500-sq.ft., vertical water-tube boilers set singly and provided with dutch-oven furnaces equipped with hand-fired stationary grates. Results obtained in economy and capacity were not satisfactory, and in 1918 two of the vertical boilers were replaced by two horizontal water-tube boilers, each containing 3,500 sq.ft. of steam-making surface and equipped with chain grates having 55 sq.ft. of active area.

It will be seen that the ratio of grate to heating surface was 1 to 64, giving a stoker much too small for the boiler, and as the headroom from the floor to the bottom of the front tube header was only 8 ft., the furnace volume also was below present-day requirements. The results obtained showed little improvement over the original hand-fired installation. Besides, there were other factors in the boiler room that were not ideal. The coal and ash handling was done by hand, requiring a great deal of labor and creating dust that found lodgment in all parts of the boiler room. A 350-ton open bin had been partitioned off on the boiler-room floor. Coal was unloaded into the boot of a bucket elevator and raised to the top of the building to be spouted into the bin in either direction from the central location of the elevator. From the bin the coal was hand-fired into the furnaces of the initial installation and later shoveled into the stoker hoppers. The ashes were shoveled out of the stoker pit and removed in wheelbarrows.

With these conditions the chief engineer, C. J. Stueber, had never been satisfied, and in 1921, when the entire plant was taken over by the present management, he presented his plan for a boiler room that would be consistent with the rest of the plant and effect savings that would soon pay for the additional investment.



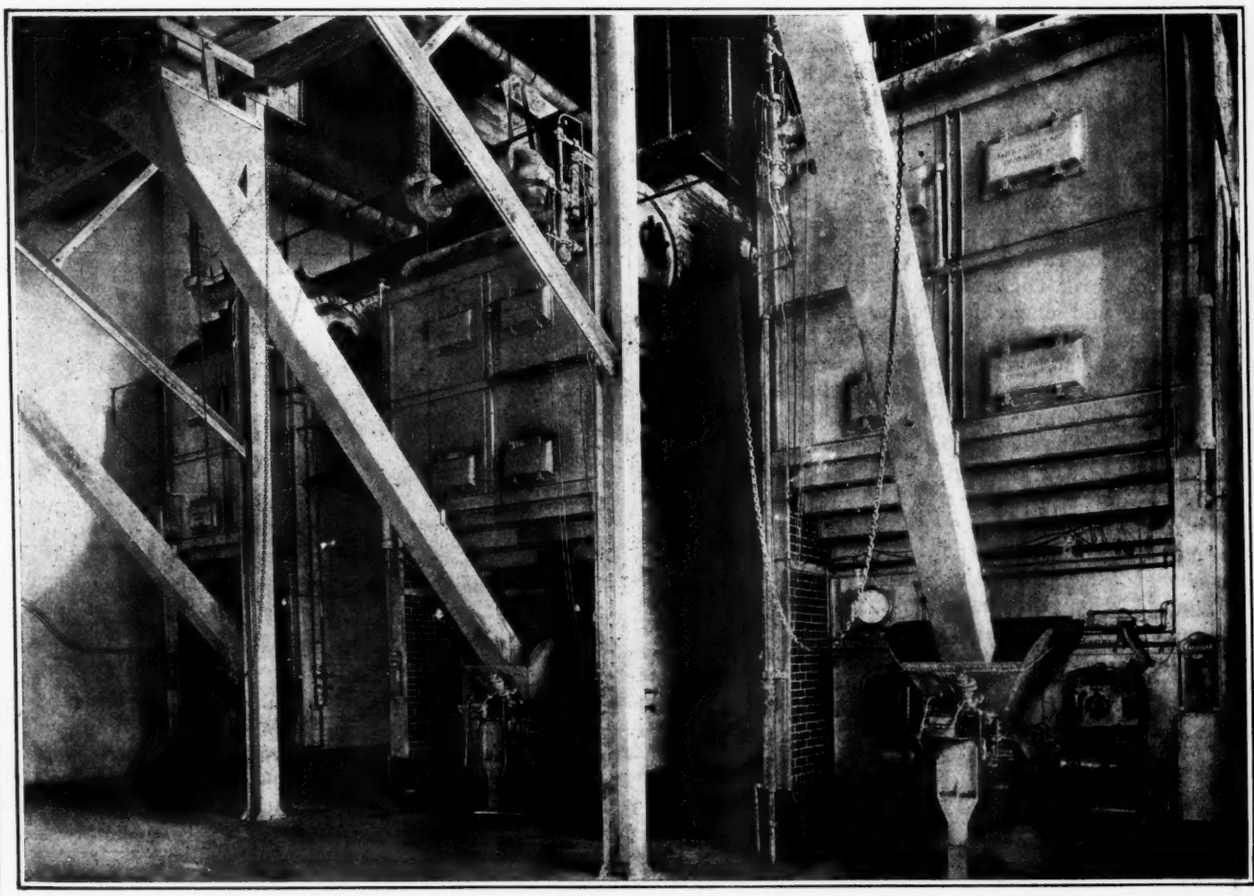


Fig. 2 (above)—The two generating units in engine room. Fig. 3 (below)—The remodeled boiler room

The decision was made to replace the boilers to make operation as nearly automatic as possible. The remodeled boiler room has been functioning for the past few months.

Three new boilers of the Kidwell bent-tube type, each containing 2,360 sq.ft. of steam-making surface, were installed, set singly and equipped with type E heavy-duty stokers designed to operate up to 200 per cent of rating. The boilers were set high, 8 ft. to the center of the mud drum, to provide a large furnace, and in the appointment of the settings considerable attention was given to appearances, as indicated in the accompanying photograph. The brick and other materials from the old settings were salvaged and used to advantage in the new work. The furnace walls were carefully built and lined with a protective coating.

The boilers were built for a pressure of 170 lb., but are operated at 150 lb. gage, and by means of the overcomer or roof tubes the steam is superheated 20 deg. Another feature is the equalizing tubes between the two top drums, which maintain the water level practically constant. For example, at normal rated load the difference in water level in these drums has shown on trial to be only ½ in. and 1.3 in. at 250 per cent of rating.

New Coal-Handling Equipment Installed

The old coal bunker on the floor was eliminated, giving a space of 28 ft. from the boiler fronts to the wall, and a new overhead cast-iron bunker of 208 tons capacity takes its place. This bunker is carried up to the ceiling so that during coal handling no dust escapes into the boiler room. The old bucket elevator is still used, but transfer is made from it to a screw conveyor with gates in the bottom of the trough to permit delivery to various points of the bunker. Rectangular chutes feed the coal to the stoker hoppers. To remove the ashes, an 8-in. steam-jet conveyor discharging against a target, makes delivery on the premises.

With the mechanical handling of coal and ash it was possible to dispense with the services of three men, reducing the operating force from 8 to 5, which consists now of three engineers, one for each 8-hour shift, one fireman and one chief engineer. On two of the shifts the engineer also has charge of the boiler room, so that two firemen and one coal passer were the men eliminated. Curtailment of the operating crew resulted in a saving of $93 a week, or $4,836 a year.

Records of coal consumption for the year 1919 show that on an average the plant used 820 tons of coal a month. From November of 1923 to May 1924, the monthly coal consumption averaged 540. As there was some variation in the outputs of electrical energy and steam, the coal consumption on a unit basis averaged 7.15 and 4.5 lb. per kw.-hr., respectively, showing a saving in favor of the remodeled boiler room of 37 per cent in coal consumption. Reducing this to a yearly basis gives a saving of approximately 3,640 tons of coal a year, and as the price per ton averaged $4.35 during both periods, the monetary saving amounts to $15,834. Adding the two items, the saving per year in coal and labor totals $20,670, which in less than two years' time will return the entire cost of the remodeling. In a plant of this size this reduction of the operating expense is remarkable, and goes to show the possibilities that are lying dormant in many other plants similar in type and service waiting to be developed.

Changing a Direct-Current Generator Into a Motor or Vice Versa

By B. A. Briggs

When considering the effects of changing a direct-current generator into a motor or vice versa, the easiest way of attacking the problem is by investigating the change from a generator to a motor, after which the reverse may be considered. As the interpole machine

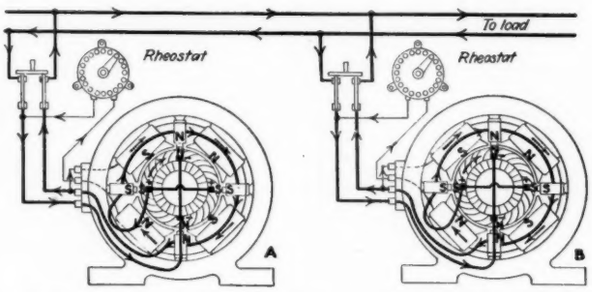


Fig. 1—Two shunt generators connected in parallel

can be made to serve to explain the effects on the non-interpole type, the former will be used in the following discussion:

In Fig. 1 are shown two shunt interpole generators connected in parallel. Assuming an armature direction of rotation as indicated by the curved arrow, the relation between the polarity of the armature and field poles is as shown. That is, in a generator the direction of the armature rotation is such as to cause the *N* poles of the armature to be carried towards the *N* main poles, likewise for the *S* poles. In either a generator or motor the polarity of the interpoles is the same as the armature poles they are over. In other words an *N* interpole

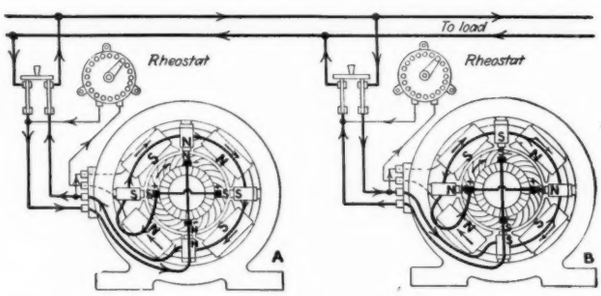


Fig. 2—Same as Fig. 1, except that machine "A" is operating "B" as a motor

is located at an armature *N* pole, similarly for the *S* poles.

If for any reason the voltage of one machine is reduced below that of the other, then the higher-voltage machine will supply a current into the lower-voltage unit and cause it to operate as a motor. For example, in Fig. 2 if the voltage of machine *B* was lower than that of machine *A*, then the latter would supply a current to *B* and operate it as a motor. In the figure the direction of the current is shown reversed through machine *B*. However, the current flows in the same direction in the shunt field coils as when operating as

a generator, consequently the main poles will have the same polarity as when operating as a generator. In the armature the direction of the current has been reversed, which will reverse the polarity of this part of the machine. This gives an attraction and repulsion between the armature poles and the main poles to cause the armature to turn in the direction of the curved arrow, which is the same as when operating as a generator. From this it is evident that a non-interpole

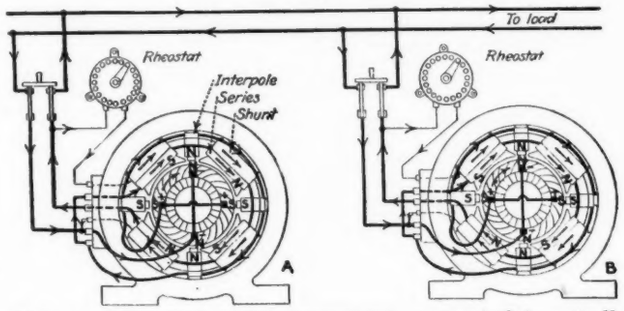


Fig. 3—Two compound generators connected in parallel

shunt generator can be converted into a motor and rotate in the same direction without any change in the armature or field connections. The converse of this must also be true; namely, a simple shunt motor can be converted into a shunt generator to operate in the same direction as the motor without any change in connections. If the direction of rotation were reversed, then it would be necessary to interchange either the armature or field connections before the machine would build up its voltage.

Considering the relation between the armature poles and interpoles, it will be seen that the polarity of both have been reversed, so that the correct polarity is main-

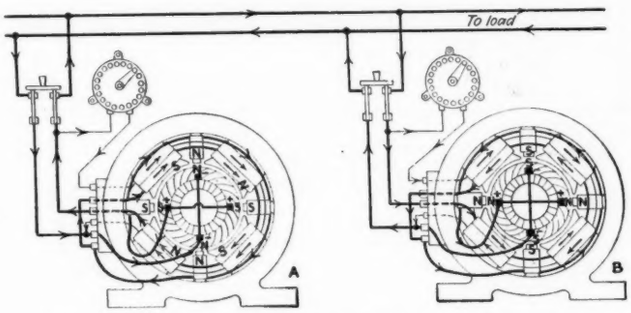


Fig. 4—Same as Fig. 3, except that machine "A" is operating "B" as a motor with its series and shunt field coils of opposite polarity

tained; that is, the interpoles and armature have the same polarity. This shows that a shunt-interpole generator can be converted into a motor without any change in connections, the same as for the non-interpole type. In the non-interpole type it would probably be found necessary to shift the brushes when changing from motor to generator or vice versa. In this type of machine the brushes are generally shifted ahead of the neutral on a generator and back of the neutral point on a motor to improve commutation. In the properly designed interpole machine the brushes are set on the neutral point.

Fig. 3 shows two compound-interpole generators connected in parallel, with the field poles and armature connected to give the correct polarity between them. If machine *B* were converted into a motor by generator *A* feeding current back into it, a condition would exist as shown in Fig. 4. In this case the directions of the current in the shunt and series field coils are in opposition, consequently have opposite polarity. Before the machine can operate as a motor, it will be necessary to cross the series field connections as in Fig. 5. In this figure the polarity of the field poles and armature are the same as in Fig. 2, which is correct for operation as a motor. Therefore, if a cumulative compound generator is converted into a motor, it will be necessary to cross the series field connections in order that the two field windings will have the same polarity. Such a procedure applies to a cumulative compound motor when converted into a generator.

Since, when the compound generator is converted into a motor, the direction of the current in the series field is reversed, it follows that if a series generator was motorized, the polarity of the field poles would be reversed and the armature would tend to reverse its

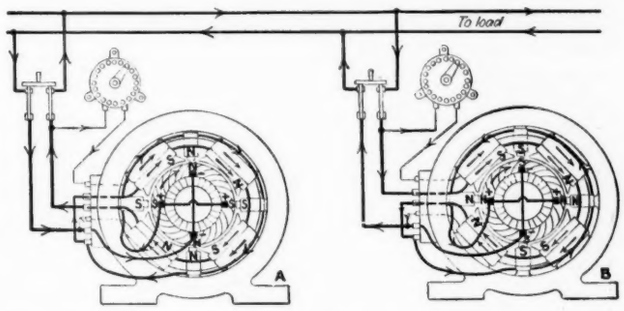


Fig. 5—Same as Fig. 4, except that series-field-coil leads have been interchanged to give the same polarity as the shunt coils

direction of rotation, which shows that if a series generator is converted into a motor or a motor is converted into a generator, the field connections must be crossed if operation in the same direction of rotation is desired.

Reports concerning construction work of the central steam heating plants for Winnipeg, Canada, describe this as proceeding briskly. Unusual success has been met with by those soliciting contracts, the full quota of steam users having been signed up according to information received. It is interesting to note that heat is here supplied from a plant built as a stand-by installation in connection with a hydro-electric development. It is expected that arrangements will ultimately be made whereby heating steam can be furnished from electric boilers in case a surplus of hydro-electric power is available for use.

A pile of hog fuel, containing approximately 7,000,000 cu.ft., is in view at Portland, Ore., being the property of the Portland Railway, Light & Power Co. Hog fuel is sawmill waste containing sawdust and trimmings from the mill. It is all put through a "hog" and reduced to small sizes. It is the principal fuel used by the railway and light companies and is burned in specially designed Dutch ovens.

Burning Boiler Oil in Diesel Engines

By C. L. RUEGG

A large amount of heavy oil is being burned under boilers for the reason that at prevailing prices it is often cheaper than coal. These oils can be used in a Diesel engine, and since the price is below that of refined oils, owners of Diesel engines should make the necessary rearrangement of the fuel system to permit them to take advantage of the situation.

THE utilizing of varying grades of fuel oils for use in connection with Diesel engines has always been a matter of vital importance in Diesel operation. While this is true in small-sized engines, it becomes a vastly greater problem with larger units, due to the greater quantity of fuel required.

In the early history of the Diesel engine it was customary to recommend an oil of 22 deg. Baumé or higher. Such fuels were easily obtainable at that time and, furthermore, the design of the engine and its devices for the handling of fuels necessitated the use of lighter-grade fuel. With the abnormal demand for light fuels as required for automotive use, the attention of oil producers and refiners has been centered on obtaining the maximum quantity of gasoline from crude petroleum. The demand for light fuels has exceeded production, causing a marked increase in price of these oils in comparison with that of heavier grades.

The ability to use grades of fuel oil as heavy as 12 deg. Baumé is quite advantageous in Diesel-engine operation. When the specifications of fuel are restricted to narrow limits, it is often difficult to get prompt delivery of suitable grades of fuel. Another reason why heavy fuels should be used whenever possible is the conservation of our natural resources. Light fuels are required for purposes for which heavier oils cannot be used. This tends to cause a surplus stock of heavy fuel which is very well fitted for use in Diesel engines. When not restricted to close limits in the grade of fuel oil required, it is always possible to purchase at advantageous prices. Excess stocks of heavy oil often exist, which is rarely the case with lighter grades.

When dealing with these heavy oils, the principal objection is the lack of fluidity and the presence of a high percentage of asphaltum. To cope properly with this difficulty, it is necessary to have a properly designed fuel pump as well as a suitable oil filter, together with a means for keeping the fuel oil at a temperature such that it can be readily handled by the fuel pump. A high temperature is necessary to filter out any non-combustible material completely, and on its way from the filter to the fuel pump the fuel must not be allowed to drop in temperature to such an extent as to tend to make the flow difficult.

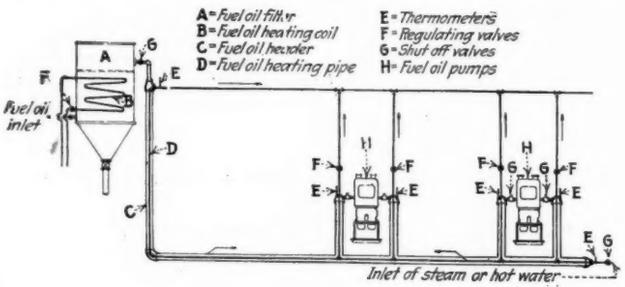

A = Fuel oil filter
B = Fuel oil heating coil
C = Fuel oil heater
D = Fuel oil heating pipe
E = Thermometers
F = Regulating valves
G = Shut-off valves
H = Fuel oil pumps
Fuel oil inlet
Inlet of steam or hot water

Fig. 2—Method of heating heavy oil

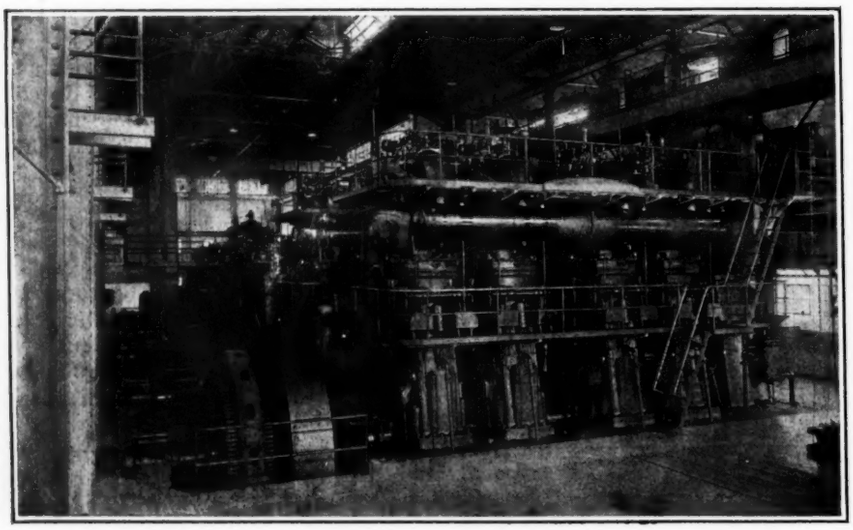


Fig. 1—Two-stroke-cycle Diesel plant using low-grade oil

When it is realized that the gravity of the oil is only in a general way a measure of its viscosity and that oils of the same gravity, if obtained from different fields, may show a wide variation in viscosity. it will be realized that the temperature of the fuel must be changed to suit the particular fuel. If, however, a fuel is used having a large percentage of light hydrocarbons, which is found in ordinary crude oil, then it will be difficult to handle it merely by heating it The light hydro-carbons will boil at a comparatively low temperature causing gas pockets to form and in that way interrupt the flow of fuel oil to the pumps, resulting in racing and poor regulation generally. The design of the fuel pump, therefore becomes very important.

The Phelps Dodge Corp. has a number of Nordberg two-stroke-cycle Diesels in operation in the Southwest and in Old Mexico. Light oils are procurable only at a price much above that of the heavy oils, consequently it was deemed imperative that the cheap oil be used. The engine builder developed a fuel pump and heating system which are designed to handle successfully fuels at comparatively low temperatures.

Fig. 1 is a view of one of these plants at Nacozari, Mexico, where 9,400 hp. of Diesels are operating at 3,500 ft. above sea level and are using with entire success 14-deg. oil containing 4½ per cent sulphur. The diagrammatic sketch shown in Fig. 2 indicates the care exercised in keeping the temperature of the fuel consistently high all the way from the fuel-oil tank to the fuel pumps. It consists of a water-jacketed fuel pipe, the fuel pipe in itself being amply large to handle a heavy fuel oil at comparatively low temperature. Steam may be used where it is available, but in most cases a special arrangement of water-jacketing the exhaust pipe from one cylinder furnishes ample hot water, which simplifies the problem materially. In cold climates it is necessary to heat the fuel in the outside

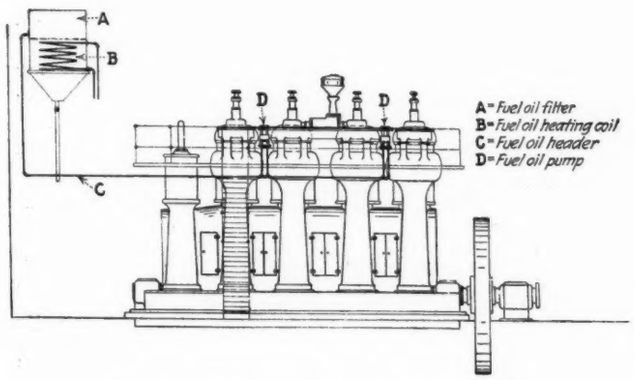


Fig. 3—Oil piping from tank to engine

storage tanks and in some instances to heat the delivery pipe from the outside storage tanks to the power house. The pumps handling the fuel from the storage tanks to the power house are usually as close to the storage tanks as possible, and are started and stopped by a remote control if they are motor driven. When the fuel has arrived in the power house, it is pumped into a daily supply tank, whence it flows to the fuel-oil filters. The highest temperature necessary in the handling of fuel oil is in the filter, so that the non-combustible particles and the water can be readily separated out. A general view of the arrangement of the fuel-oil tanks and engine is shown in Fig. 3.

Depending on the quantity of light hydro-carbon in a fuel, it is necessary to keep the fuel-oil temperature between 100 and 150 deg. F.; it is seldom safe to go higher for fear of forming gas pockets. In the arrangement described herein, the temperature of the water available in the exhaust header may be as high as 180 deg., which gives ample temperature difference to realize the proper temperature of the fuel oils at all times.

Where such heavy fuels are used, necessarily the Diesel engine must start with a light fuel, which may be anything that will flow at the lowest temperature to which the engine will be subject. The Phelps Dodge Corp. has found that 32-deg. Baumé paraffin-base oil is entirely unsuitable since it forms a jelly-like substance when chilled; an asphaltum-base oil of 24 deg. stays fluid at low temperatures and is used on starting and stopping.

When the water has been heated sufficiently in the exhaust header and a flow of warm water established through the fuel filter and jacketed fuel-oil pipes, the temperature of the heavy fuel is rapidly increased and is available for use from 10 to 30 minutes. Necessarily, all fuel lines must be so constructed as to be easily cleaned. The water-jacketed space seldom requires attention, but if the power house is subjected to freezing temperatures, perfect draining of all the water must be allowed for.

Starting and Stopping Steam Turbines

By Claude C. Brown

An important factor in the operation of steam turbines and one that has a great deal to do with the successful performance and the minimizing of repair and upkeep costs is the manner in which each unit is started up and shut down. This is especially true of small units, which are too often handled carelessly by the operators in charge, who, because they are small, do not give them the careful attention a larger and more important unit would receive. The standard procedure for starting up and shutting down some three-stage, 3,600-r.p.m., 140-160-lb. throttle pressure, 10-15-lb. exhaust, rigid type frame, 1,875-kva. turbine units is:

The operator first opens the drains in the main steam supply piping, the valve chest and the wheel casing. He then admits full oil pressure to the governor pilot valve from the circulating system of an operating turbine if one is running, or from a small auxiliary pump if the power plant is completely shut down. Cooling water to the bearings is adjusted and a few drops of oil applied to the governor and valve gear connections.

The throttle valve is opened far enough to start the unit revolving slowly, care being taken not to allow steam to blow through the turbine without turning the rotor. Inspection of the machine is made to see that the bearing oil rings are turning freely, that the feed valves from the oil-pressure system to the bearings are properly adjusted and that the oil pump is operating correctly and pumping oil.

After allowing an interval of several minutes for the piping and turbine casing to become heated up and become thoroughly drained of condensation, the throttle is gradually opened and the turbine speed increased to normal. During this operation the governor is watched carefully to make sure that the unit comes thoroughly under the governor control.

Bearing-oil feed lines are then adjusted to the proper pressure, which is 25 lb., and the throttle valve is opened wide. The direct-connected exciter voltage is brought up to 125 and the generator field switch closed with all of the generator field resistance in service. Generator voltage is raised to 480, making the unit ready for synchronization. The generator speed is regulated from the board and the machine synchronized and loaded, after which the various steam drains are adjusted for operating conditions. The auxiliary source of oil supply is discontinued, the oil strainer cleaned if necessary, and other adjustments attended to.

Upon shutting down a machine, the reverse operations, generally speaking, are gone through with. The load is taken off, the main switch opened and the unit speeded up so as to trip out by the action of the emergency overspeed device.

If, when shutting down a steam turbine, both the throttle and emergency valve are closed and a drain between them opened to atmosphere, then steam pressure will be prevented from reaching the throttle and leaking into the turbine.

Low-Temperature Carbonization of Coal

By C. M. GARLAND*

IN THE carbonization of coal by the low-temperature process, up to the present time there have been two general methods of procedure: First, coking in some form of stationary retort and after the material is coked, of crushing and screening to size; second, of coking the material in some form of retort in which the coke is agitated or forced through the retort by some mechanical means and emerges from the retort in the form of coke breeze. If this breeze is to be used for domestic purposes, it may be briquetted and sold in the form of raw briquets or it may be briquetted and recoked as in the Carbo-Coal process.

In the first method of procedure a satisfactory coke can be produced although it labors under the disadvantage of greater porosity, consequently a greater bulk for a given weight, and is more fragile than a high-temperature coke. To offset this disadvantage, however, it ignites more readily and, so far as the combustion process is concerned, is a superior fuel to high-temperature coke.

COAL coked evenly and continuously by superheated steam at one pound pressure generated from volatile and residue of coking process. Including fixed charges on investment the cost of treating coal containing five per cent moisture is estimated at eighty cents per ton.

In addition to these disadvantages in the product itself there has been the greater disadvantage of the inability to coke at low temperature in large masses, such as are comparable with the high-temperature process. This has been due to the fact that when the finely divided coal is placed in the retort, this finely divided material forms an excellent insulating medium preventing the conduction of heat to the center of the mass. This has been illustrated by the experiments of Simmersbach in which coal was charged into a Koppers oven having a mean width of 18⅞ in. and operating on a 29 hours' coking time with a final maximum temperature of 1,120 deg. C. During these experiments it was found that the temperature remained at about 10 deg. C. for 2½ hours after charging at a point in the middle of the oven about three feet above the floor. This temperature then rose to 100 deg. C. and remained at this point for thirteen hours after charging. At twenty hours after charging, the temperature in the center had risen only to 410 deg. C.

Difficulties Encountered

These experiments illustrate the insulating property of the finely divided fuel and the difficulty of coking to the center of the oven with the temperature as high as 2,600 deg. F. in the side walls of the retort. They show that with a temperature of only 1,000 or 1,200 deg. F. in the side walls it never would be possible to coke coal in large volumes by the low-temperature process in a manner comparable with coking at high temperatures. The coal in the center of the retort would not coke, while that at the sides of the retort would be overcoked.

To eliminate this fundamental disadvantage in coking by the low-temperature process, the writer has designed the retort shown diagrammatically in Fig. 1 on which United States patents have been granted. In this retort the vertical side walls *B* are provided with a plurality of perforations *C*. The material is charged into the retort through the door *G*. The retorts may be made similar in size to retorts used in high-temperature coking and may be of the horizontal, vertical or inclined type. The retort shown in Fig. 1 is of the horizontal type, in which the coke is pushed from the retort by some type of mechanical pusher such as is used in the high-temperature process.

How Coking Is Expedited

To make coking rapid, the coal is coked by causing a heating medium to flow in through the side walls of the retort and the coal contained therein. Most any non-oxidizing gas may be used for the purpose, such as products of combustion, producer gas, superheated steam or mixtures of any of these gases. For general convenience in operation and in order not to contaminate the gases generated from the distillation, it is desirable to use superheated steam for the heating medium. This is desirable also from the standpoint of specific heat, as the specific heat of superheated steam is about twice that of any other gas available for this purpose. In addition, the superheated steam is condensable and leaves the products of distillation free of contaminating gases.

For carrying out the process the steam is superheated so that its temperature upon reaching the retort is in the neighborhood of 1,100 deg. F. To keep down the size of pipes for conducting the steam to the retort, it is desirable to superheat the steam under a pressure of at least 50 lb. gage. The steam is then expanded in the heating chamber *D* to a pressure of about 1 lb. gage, or just sufficient to overcome the resistance of the retort.

The coal is crushed to size, charged through the door *G*, and is then leveled off in the retort. Superheated steam is admitted through the pipe *N* with valve *O* open. The valves *Q*, *R*, *P* and *K* are closed while the valve *I* is left open. Steam passes through the pipe *L* to the pipe *T*, which extends lengthwise of the retort and is perforated to discharge superheated steam in the direction of the arrow shown in the heating chamber *D*. This steam passes through the perforations *C* in the side walls *B* and out through the pipe *U*, which is also perforated and extends lengthwise of the retort. This steam and the products of distillation then pass out through the pipe *H* and the valve *I* to the scrubbing apparatus. At the end of a given period the valves *O* and *I* are closed and the valves *R* and *K* opened. Superheated steam is then passed in the opposite direction through the retort.

Steam is passed through the retort in opposite directions to insure uniform coking, and the flow is continued until the coal contained in the retort is fused and ordinarily until there is a sudden rise in temperature

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in the mass of the coal. After this has occurred, the valve *R* is throttled down and the valve *O* slightly opened. The valves *I* and *K* are both opened, and steam is allowed to flow slowly through the heating chamber *D* and out through these valves until the coking operation is completed. The valves *O*, *R* and *I* are then closed, while the valves *Q* and *K* are opened. Saturated steam at a temperature of about 220 deg. F. is then passed through the retort for a few minutes until the coke has been quenched.

It will be seen from the foregoing that the advantages of this form of retort lie in the fact that the low-temperature coke may be produced in volumes comparable with the high-temperature process. In addition to this the time of coking need not exceed three hours, so that a retort of given size will have in the neighborhood of four times the capacity per day of a high-temperature retort of the same size.

The first cost of a retort of a given size, it is believed, will be about 80 per cent of the cost of a high-temperature retort of the same size, but the first cost of the retort per ton of coal coked per twenty-four hours, probably would be less than 20 per cent of that of a high-temperature retort of the same capacity. Owing to the rapid time of coking the operating costs and maintenance charges per ton of coke made also would be small as compared with the high-temperature process.

Owing, therefore, to the low first cost of the plant per ton of material coked and the low operating expenses, the writer believes that the retort under description possesses great possibilities in the matter of low-temperature coking from the commercial viewpoint. The product from this retort may be crushed and screened to size and sold as a domestic fuel, or it may be crushed and briquetted for the production of a fuel

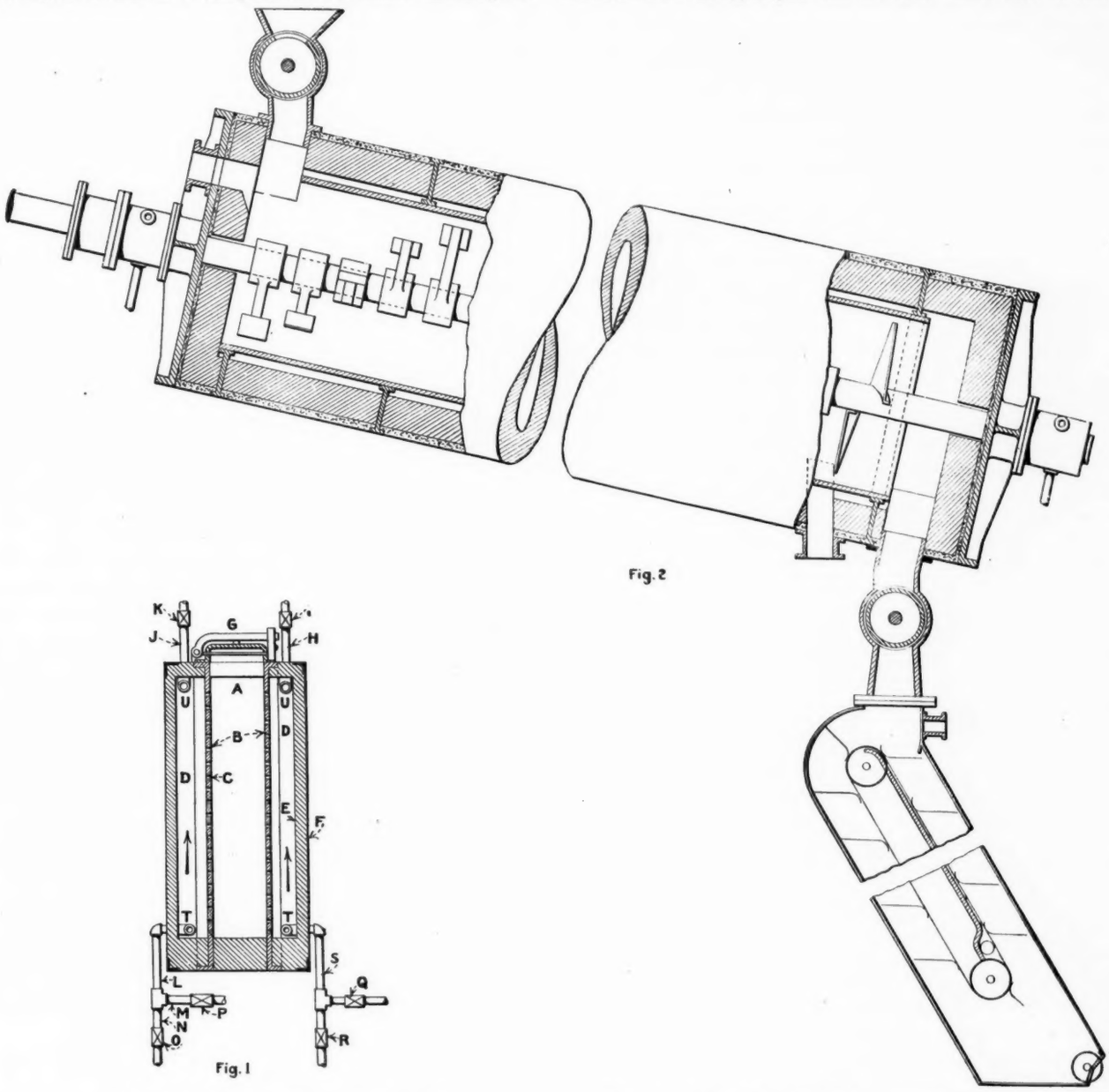

Fig. 1—Retort using superheated steam to coke coal

Fig. 2—Retort designed for continuous removal of byproducts from boiler coal

"de luxe." From the engineering point of view there would seem to be no serious difficulties to be encountered. The temperature in the retort would be in the neighborhood of 1,000 deg. F., which is a temperature that does not affect to any appreciable extent either cast iron or cast steel at the low pressure under which it is used. Standard high-temperature doors, pushers and other auxiliary apparatus can be used for charging and discharging the retorts.

Standard Superheaters Can Be Used

In the superheating of the steam, standard superheaters can be used for this purpose and have been employed for superheating steam to as high as 1,200 deg. F. without excessive repair costs. So far as heating is concerned, the process is much simpler and much more easily regulated than the high-temperature process. All the heat for the retorts would come from a central boiler plant, conducted through steam lines. The apparatus is not only suited for the coking of coal, but can be used for the distillation of shale and poor grades of coal for the recovery of byproducts.

A number of investigators have demonstrated in the coking process when using a given fuel, that the coke produced, the amount of tar and the amount of gas and the quality of these depend primarily upon the temperature at which the coking operation is carried out. With this fact in mind and from the foregoing description, it will be realized that practically the only unknown quantity in the operation of the retort in question is whether or not the passage of the steam through the material to be coked will produce a coke that is too porous for commercial use.

In order to test this point, a small laboratory retort was set up in which a block of coke 10 in. in diameter and 12 in. long could be produced. This retort consisted of a cylinder provided with two perforated sheet-metal diaphragms between which the coal was charged. Steam under a pressure of 10 lb. was superheated by passing it through a pipe coil heated with bunsen burners using illuminating gas. The temperature of the steam was approximately 1,050 deg. F., and as it was passed through the retort the pressure was reduced to about one pound. Illinois Franklin County coal, shale, oil sands and lignite were tested.

Testing Franklin County Coal

For the Franklin County coal approximately 2½ hours' time was required to make a block of coke 12 in. thick and about 10 in. in diameter. It was found, as might have been expected, that with too high velocity of steam through the coal, especially where the velocity was maintained until coking was complete, the coke was too porous for commercial conditions. However, when the steam was reduced to such a velocity as corresponded to a pressure of about one pound per square inch before the retort, it was found that a coke could be produced in approximately 2½ hours that had about the same density as low-temperature coke produced in retorts in which the heat was conducted through the side walls. As a matter of fact samples of the coke made by passing the steam through the coal could not be separated after mixing with samples of low-temperature coke that had been made in retorts in which the heat was conducted through the side walls.

In this experiment the steam was passed through the coke until the coking was completed. This coke, while not so dense as high-temperature coke, was entirely suitable for domestic purposes and was as good a coke as the writer has seen produced by the low-temperature process. The experiments seemed to be conclusive on the matter of porosity.

In the case of the shale tested, an excellent quality of shale oil was produced in approximately 2½ hours when the shale had been crushed to pass a ⅜-in. screen. The temperatures used were approximately 1,000 deg. F. In the case of oil sands it was found that there were not sufficient voids between the particles of sand to permit the steam to pass. The result was that channels were formed and a large portion of the sand was carried over into the condenser.

The lignite tested produced as a residue a semi-fused charred substance. It is generally recognized that lignites so treated do not produce a coke, but that the charred substance can be used under boilers and, if desirable can be briquetted for the production of a domestic fuel. The coke residue obtained in the distillation of this lignite would have to be briquetted if it were to be used for domestic purposes.

While the coke from a retort of this type can be crushed and used under boilers, it is believed that this process is unnecessarily expensive for removing the volatile products from coal for boiler furnaces. There is little doubt that it is only a matter of time until all bituminous coal will be devolatilized before burning.

Retort for Removing Byproducts

For the removal of the byproducts from boiler coal, particularly coals with little tendency to coke, the writer has designed the retort illustrated in Fig. 2. This retort is continuous in operation. Superheated steam enters at one end and passes counter-current to the flow of the coal, which enters at the opposite end of the retort. An experimental retort of this type, built approximately 10 ft. long and 2 ft. inside diameter, has been used in numerous tests on shales and has given excellent results. Up to the present time no tests have been run on non-coking bituminous coals, but the operation on shales demonstrated conclusively that this form of retort is a practical piece of apparatus in which any non-coking bituminous fuel can be devolatilized quickly and economically with a large yield of byproducts high in the lighter fractions.

There has been some question relative to the economy of these processes using superheated steam as a heating medium. It has been pointed out that the large quantity of steam required for distillation will make the cost of the process prohibitive. These statements undoubtedly are made by engineers who have a superficial knowledge of the process.

With superheated steam, the amount required will depend largely upon the moisture content of the coal, and if this moisture content runs over 10 per cent, it is probable that it would pay to dry the coal before retorting. This intial drying can be effected by the use of the flue gas from the boilers, so that no additional heat will be required for this purpose. The coal would be passed through a rotary drier in the opposite direction to the hot gases from the boilers.

A coal containing approximately 10 per cent moisture will require about one pound of steam at approximately atmospheric pressure and at a temperature of 1,100 deg. F. per pound of coal treated for its distillation without drying.

Each pound of coal treated will yield approximately ¾ cu.ft. of gas, having a calorific value of 800 B.t.u. per

cu.ft., so that 600 B.t.u. will be available from the gas for generating and superheating steam. In addition to this there will be coke and carbon refuse from the process, representing about 5 per cent of the weight of the coal treated. The net result is that approximately 0.07 lb. of coal will be required in addition for raising steam per pound of coal treated.

If the cost of this coal is taken at $4 per ton delivered to the boilers of a plant that has a capacity of 600 tons in 24 hours, the total cost of heating per 1,000 lb. of coal treated will be 29¼c. or 58½c. per ton, which includes all labor charges, interest on the investment at 10 per cent, repairs and maintenance. While this may be considered a low cost for the generation of steam, yet it should be understood that this is a plant which operates 24 hours a day and practically 360 days out of the year. Consequently, the load factor is high. The efficiency of the boilers day in and day out has been assumed as 70 per cent, which under the load factor, is a conservative estimate. This cost is obtained on the assumption that the feed water for the boilers is returned at 212 deg., which can be accomplished easily, as the gases from the retorts will pass to the economizers and scrubbers at a temperature in the neighborhood of 500 deg. F.

If it is assumed that dry coal is treated, approximately one-half pound of steam per pound of coal will be necessary, and the gas combined with the 5 per cent waste carbon from the process will be more than ample to generate this amount of steam. The cost for steam will then be approximately 12½c. per ton, which covers interest on the investment and labor. It will be seen that under practical operating conditions the cost of heating for the retorts will vary from 12½c. per ton of coal treated for dry coal, to 58½c. per ton of coal treated for coal containing 10 per cent moisture. With coal containing 5 per cent moisture, which may be considered as an average fuel, the total operating costs of a plant having a capacity for treating 600 tons per 24 hours will be in the neighborhood of 60c. per ton and fixed charges on the investment about 65c. per ton, making a total cost of $1.25 per ton of coal treated, on the assumption that the plant is in operation 360 days per year. These figures apply to the stationary retort process for the production of a domestic fuel.

For the removal of the volatile products from boiler coal using the continous process, it is estimated that a coal containing 5 per cent moisture can be treated for not exceeding 80c. per ton, including fixed charges on the investment. This figure of 80c. per ton applies approximately also to the treatment of shale for the recovery of shale oil.

Quality of Bled Steam

Two problems have recently been given considerable attention in connection with the heating of feed water with bled steam. The first is the effect of superheat in the bled steam upon the rate of heat absorption in the bleeder heater. Contrary to earlier notions a number of investigations covered by recent articles in *Power* seem to show that superheat has little effect upon the total rate of heat absorption and that desuperheaters are unnecessary.

In connection with the bleeding of steam from the lower stages where a considerable percentage of moisture is present, it has been suggested that suitable design of the turbine and the bleeder connections might result in the bleeding of moisture in addition to the percentage normally associated with the bled steam. This would naturally raise the turbine efficiency.

The following abstracts from the May report on Heat Balance issued by the Prime Movers Committee of the N.E.L.A. are a practical discussion of these two points.

One member company, in making investigations on an experimental condenser, advises that if, in finding the B.t.u. heat transfer per square foot per degree difference, the temperature difference used be the mean difference between the temperature of the water and the temperature of saturated steam corresponding to the pressure of the superheated steam, in place of the actual superheated steam temperature, then the heat transfer per square foot per degree difference will be within a small percentage of the heat transfer with saturated steam.

Corresponding tests made on an evaporator indicate that when the temperature head is obtained by taking the temperature corresponding to the steam pressure rather than the actual superheated steam temperature, the heat transfer per square foot per degree difference is slightly increased, as is the capacity of the evaporators.

Three other member companies, one using a film type and two others a coil type of evaporator, report that with reference to evaporator capacity it is immaterial whether the steam is desuperheated or highly superheated.

Moisture in Bled Steam

It has not been possible to obtain a definite opinion from the manufacturers as to whether the amount of moisture that extraction heaters draw off is sufficient to make any difference in the turbine efficiency. The opinion of two of the three manufacturers is that this moisture is in such finely divided particles that the bleeder heaters do not draw off more with the bled steam than the average percentage at that stage.

An investigation of turbines in operation by a member of the committee indicates that where the blades are not shrouded, the moisture is thrown to the outer end of the blade. If this moisture can be drained off, it will undoubtedly do a great deal to reduce blade maintenance and to maintain initial turbine efficiency. Modern turbines are being designed with fewer blades, the blades being larger so that more work is done in the turbine per stage.

The separation of the water in the lower stages of the turbine is attracting a great deal of attention among engineers and manufacturers, and while the investigations that have been made so far are theoretical only, it is probable that next year will produce test data that will be of importance in guiding future developments.

The introduction of additional heaters from the point at which moisture begins to appear in the main unit—that is, at approximately atmospheric pressure—will not reduce the size of the low-pressure heaters, so that each additional heater that is installed will be an increase in cost. The installation of additional heaters, however, will simplify the matter of drainage, as "U" bends can be installed between the various heaters, and they will be short enough so as not to require the construction of wells for the bottom of the bends or the locating of the heaters at an inconveniently high point in the plant.

Hydro-Electric Practice in Norway

By HENRY A. PULLIAM*

The author made a trip through Scandinavia with the World Power Conference Tour and in this article gives his observations on the hydro-electric plants in Norway. Being a trained engineer familiar with this class of work, he has been able to present a comprehensive picture of the construction and operating methods used in the section of the country of which he writes. To those operators who have ice problems to contend with in this country, how they have overcome these difficulties in Norway will be of particular interest.

NORWAY is more favorably situated with reference to water power than any other country in the world. The total available water power of Norway is estimated at 12,300,000 hp. by government engineers. However, some authorities consider that 16,000,000 to 18,000,000 hp. is a more reasonable estimate. At present 1,820,000 hp. is being utilized and a high degree of electrification has been reached at the lowest cost per horsepower that has been attained anywhere in the world. In the west high-head power developments are the rule, of which the highest are the plants at Björlve, with a head of 2,840 ft., and at Flörei, with a head of 2,420 ft. There are at least eleven other possible practical developments of heads approximately one-half mile and greater. In the eastern part of the country low heads with greater volumes of water prevail.

In most respects hydro-electric practice in Norway differs but little from current practice in other countries. The heads utilized for the larger plants varies from about 35 to 2,840 feet.

The topography of the mountainous parts of the country dictates that heads for hydro-electric installations be developed by means of tunnels and aqueducts rather than by the concentration of the fall of streams by dams for immediate utilization at the dam sites. Consequently, most of the dams are for diversion and storage purposes and high dams are the exception. The slopes of many of the streams are so great that high heads can in many instances be developed by the construction of tunnels of moderate length. At Tyssedal tunnels 11,300 ft. long produce a head of 1,360 ft. and a generator capacity of 142,500 hp. At Samnanger a tunnel 13,110 ft. long makes possible a head of 492 ft. and a power development of 60,000 hp. A tunnel 5,000 ft. long gives a head of 2,840 ft. at Björlve and a possibility of 40,000 hp. At the Saaheim Rjukan plant a tunnel 23,000 ft. long gives a head of 820 ft. and a capacity of 164,000 hp. All these tunnels are unlined.

In the lowlands in the southeastern part of the country, where the slopes of the streams are more moderate, the heads are developed principally by means of dams with power houses adjacent. The Vamma plant, with a head of 90 ft. and a capacity of 90,000 hp., and the Solbergfos plant, with a head of 70 ft. and a projected capacity of 150,000 hp., are examples of this type of construction, both being within 30 miles of the capital and industrial center, Christiania.

The materials of construction of the dams do not differ greatly from the materials used under similar conditions in the United States or elsewhere. The present trend of construction is the use of concrete gravity sections, and the protection by granite masonry

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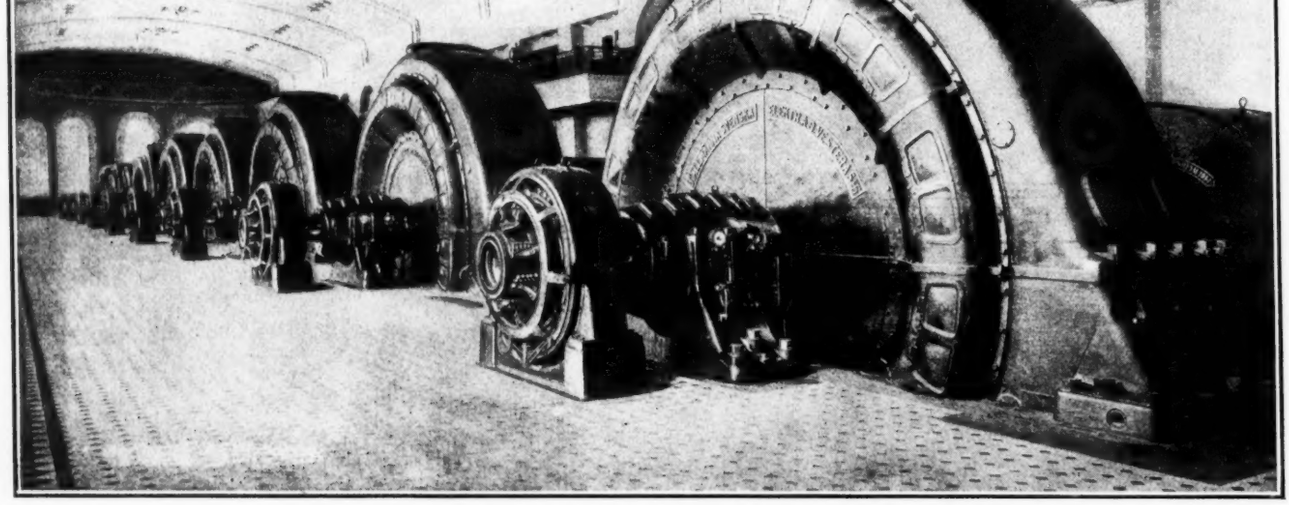


Fig. 1—Rjukan plant, Norway, contains ten 16,400-hp. units

of surfaces exposed to ice, floating logs and other erosion. Scandinavian engineers expect the use of reinforced-concrete arch dams to increase for northern construction and high altitude compounding of water.

For the moderate- and high-head plants the connection between the source of water supply and the penstocks is generally secured by means of tunnels. Since the slopes of the hillsides are precipitous and

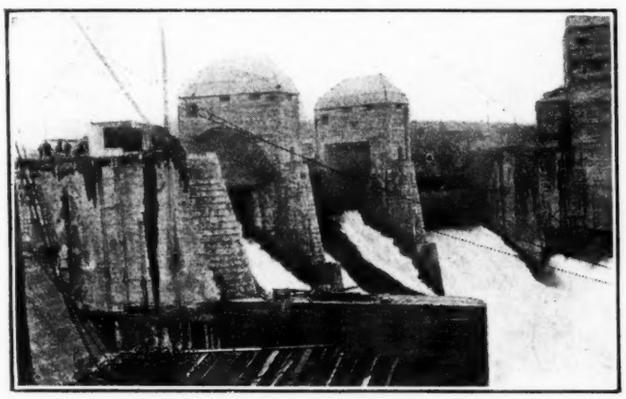


Fig. 2—Roller dam flood gates, Glommen River, Norway
Gate on left is full open, middle gate is about half closed, and the gate on the right is nearly closed.

rugged and most of the excavation is very hard rock, the construction of canals in the mountains is not customary. Flumes are practically prohibited by the climatic conditions as well as the economy of construction. The practice is not to line the tunnels with concrete but to leave the naked rock. The rock through which most of the tunnels are driven is difficult to work to a smooth surface, yet lining is placed only in those parts where fissures and cracks or loose materials are encountered.

In the low-head developments short canals are to be found. These canals, for the most part, convey the water around rapids and small cataracts in short stretches of the rivers and are generally less than one-quarter or one-half mile in length. In the designing of canals for this climate consideration must be taken of the reduction of useful sectional area and of the action on the canal wall caused by the ice.

Type of Penstock Construction

Riveted, welded and cast-steel pipe is used in penstocks, much of it of English manufacture. Some of the riveted pipe is pressed to form ball-and-socket joints, thus obtaining a smoother surface on the interior of the pipe. At the lower ends of the penstocks of some of the high-head plants welded pipe reinforced at intervals with shrunk steel rings is in use. At some plants the pipes are painted white to reduce the expansion under the sun's rays.

The rugged topography makes it economical at places to install the penstock pipes in tunnels. In some instances the tunnels are made large enough to accommodate more than one pipe line, in addition to an inclined cable-drawn railway and a flight of stairs. Other advantages of placing the pipes in tunnels are the reduction of temperature stresses and the elimination of any tendency to the formation of crusts of ice inside the pipes during excessively cold weather and especially if the water is not used at night. The Herlandsfossen plant is an exception to the rule in that pressure tunnels are used instead of pipe lines.

The method of construction and the utilization of gates for the openings in dams and intakes to canals, tunnels, penstocks and turbine chambers do not differ in any marked way from the practice in some other parts of the world. Flood control for the spillways of some of the dams of the larger rivers is effected by "roller dams" such as indicated in Fig. 2. It is a form of gateway that has seen some popularity in Germany, and consists simply in stopping the weir of the spillway with a steel drum built nearly cylindrical in shape and laid in the weir with its axis horizontal. To open the gate the drum is rolled up an inclined trackway on which its ends rest. Roller dams of this type are adapted to large openings owing to the rigidity of their cylindrical construction, and are especially useful in rivers of large flow and much ice and where logging operations are maintained on a large scale. They are easily operated even in winter. Devices for electrically heating the planes of contact of the ends of the drum and the dam have been perfected for use during freezing weather. Compared with other movable dam units, the roller dams are relatively expensive to build.

Ice Troubles and Remedies

Norwegian hydro-electric plants have become very experienced in combating ice difficulties. Formerly, ice occasioned many interruptions to service, at times causing complete shutdown of plants, but present-day methods have removed most of the hazard to continuous operation.

Needle ice, or "frazil ice" and drifting block ice have been the chief source of trouble. Needle ice is characteristic of streams where a turbulent current prevents the formation of a continuous sheet of surface ice.

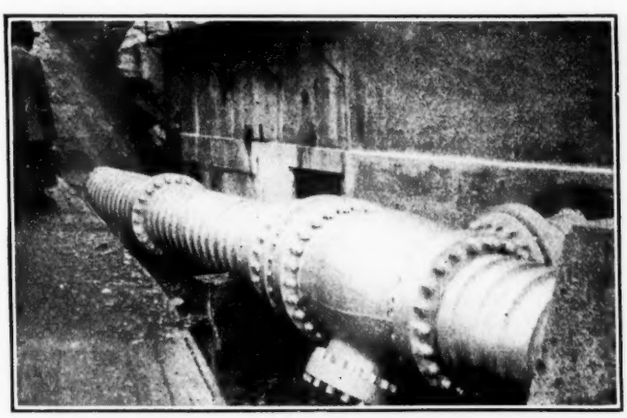


Fig. 3—Lower end of penstock under 2,840 ft. head at Björve plant, Norway
Penstock is made of welded steel pipe with steel shrink-ring reinforcing.

The needles vary in size, but are usually about ¾ in. long and $\frac{1}{16}$-in. in thickness. They adhere to any solid object encountered as they are carried along by the current, sometimes forming large blocks of "anchor ice" on rocks at the bottom and sides of the stream. Large accumulations of needle ice are frequently carried along below surface as floating masses. Although the ice needles at times form serious obstructions to the flow in rivers, canals and forebays, their chief hindrance is their adhering to the screens at the entrance to pen-

stocks and turbine pits, where they have caused partial and complete stoppage of flow.

Some of the remedies that have been employed to eliminate the troubles from needle ice are as follows: The scraping of the screens by large groups of laborers, as many as fifty men sometimes; mechanical scrapers; replacing the steel screens with wood to which the needles do not so readily adhere; entire removal of the screens, especially where the amount of ice is small and the turbines large; conducting hot air from the generators to the screens; substituting for the steel bars hollow tubes into which steam is introduced to heat the bars and prevent the sticking of the ice to the screens; and heating the screens with an electrical current. Of all remedies the heating of the screen bars with an electrical current has probably been most successful. Single bars or groups of bars are connected in series. With a water velocity of not more than 2.3 ft. per sec. and a bar section of not more than one square inch sufficient heating is usually secured with 300 amperes per bar at 50 cycles.

Full Development of Rivers Prevents Ice Troubles

Drift ice is not troublesome at plants where the water supply is taken directly from reservoirs of large surface area, for in such cases the surface ice prevents the drift from reaching the screens. Reservoirs located in this manner, close to the power intake, are also protection against needle ice, for they offer an opportunity for the needle ice that is washed in from above to rise and adhere to the surface ice before reaching the intake.

Where the headrace canal takes its waters at a simple diversion dam, ice entering the canal is disposed of over ice sluices. Under such conditions a rough network of timber is frequently placed in the river above the intake to assist the formation of surface ice. The accumulation of masses of drift and needle ice in the canals, especially at the upper ends, has at times been combated by the careful use of dynamite.

As additional power developments are constructed on a river, the troubles from ice are reduced. As the cataracts and rapids are replaced by the still water of the reservoirs, the formation of needle ice is reduced. Furthermore, as regulating works are constructed, it becomes possible to draw the water supply from the lower and warmer depths of the reservoir, which aids materially in keeping even the unregulated parts of the streams below warmer, and thereby reducing the formation of needle ice.

Another occasional source of trouble is the reduction in flow of the streams by reason of the formation of ice. In one stream which has a regulated winter flow of 1,236 cu.ft. per sec. the formation of ice has cut down the flow by more than 25 per cent. In the Glommen River, the largest in the country, with a regulated winter flow of 7,770 cu.ft. per sec., the reduction of flow has amounted to 13 per cent. This trouble can at times be offset by increasing the discharge from reservoirs, although this relief is not always efficient when the reservoirs are remotely located in the mountains and several days are required for the released water to reach the plant.

There is no outstanding individuality about Norwegian turbine practice. Their turbines have been supplied, not only by Norwegian manufacturers, but from several other European countries. Especially for large installations, the Norwegian plants have imported heavily from Sweden, Switzerland, and to some extent from Germany. However, some of the largest turbines have been made in Norway, and the Norwegian factories are making strides toward supplying the entire domestic demand.

In the high-head plants are found impulse turbines with both one and two runners, one jet to the runner, and practically universally of horizontal axis. As an example of the efficiencies obtained from these Pelton wheels, the Rjukan plant, built about ten years ago at Saaheim, attains about 85 to 86 per cent under a net head of 820 ft., a speed of 250 r.p.m. and a capacity of 16,400 hp. per unit. The turbines are double-runner units. Originally, the efficiencies of some of the turbines did not exceed 82 to 83 per cent, but changes made in the design of runners raised this to 85 and 86 per cent. Manufacturers state that the turbines of the same type now being turned out by Norwegian factories (1924) attain 89 per cent and 90 per cent efficiencies.

In the moderate and low-head plants the horizontal, Francis type of turbine predominates. However, at a plant now under construction at Morkfos-Solbergfos the turbines are vertical-shaft, single-runner, Francis types. Each unit will develop 11,500 hp. under a head of 69 ft. and 150 r.p.m.

Examples of Turbine Efficiency

As examples of the efficiencies of low-head developments of recent date, the Raanaasfos plant,[1] which was constructed about two years ago, has six double-runner, Francis, horizontal units designed for 12,000 hp. each, at 107 r.p.m., and a net head of 40 ft., of which three turbines attain a maximum efficiency of 90.1 per cent.

High speeds have been emphasized in the Scandinavian practice for low-head turbines in order to reduce the cost of direct-connected generators. Topographical advantages have made possible the lowest cost of power development in the world. Consequently, the cost of the generating machinery bears a higher ratio to the total cost of the development than it does under such conditions as are encountered in the United States. To attain maximum economy, it is important to reduce the cost of the power-house equipment, even at a small reduction in the efficiency of the turbines. In America the cost of the generating equipment is generally a smaller proportion of the total cost of the development, and economy demands that turbine designers concentrate more on efficiency than on features that will reduce the cost of the generating units. As a consequence, where the American practice has run to the vertical-shaft, single-runner, reaction turbine, from which it is generally recognized the highest efficiency can be obtained, the Scandinavian practice has developed the horizontal-shaft double-runner turbine, from which during the last few years they have been most successful in obtaining high specific speeds under low heads.

Adjustable-Blade Turbine

It might be mentioned here that a Swedish company is now producing the Kaplan adjustable-blade, vertical-shaft, single-runner turbine, which is reported to have the highest specific speed yet attained in any turbine. One of this class of turbines is being installed in the new plant at Lilla Edet,[2] Sweden with a capacity of

[1] Described in *Power*, Feb. 19 and April 8, 1924.
[2] Described in *Power*, Nov. 13, 1923.

10,000 hp., at 62.5 r.p.m., corresponding to a specific speed of 600 metric or 135 in the foot-pound system, a head of 21.3 ft. and a guaranteed efficiency of 84 per cent at full load, 87 per cent at ⅞ load, 88 per cent at ¾ load, 87 per cent at ⅝ load and 86 per cent at one-half of full load. The runner will have a diameter of over 19 ft. Accompanying this unit will be two 10,000-hp. Lawaczeck turbines, built by another Swedish company, with vertical shaft, single runner, fixed blades and a speed of 62.5 r.p.m., corresponding to a specific speed of 135, the same as the other turbine, and a guaranteed efficiency of 83 per cent at full load, 87 per cent at ⅞ load and 65 per cent at half of full load. The runners of the Lawaczeck machines will have diameters of 19 ft. 8¼ in., making them the largest turbine runners in the world.

Like the turbines and most of the electrical equipment the generators in Norwegian plants give a good cross-section of northern European practice. Besides those produced in Norway, generators have been imported from Sweden, Great Britain, Switzerland and other countries. Possibly the most distinguishing feature of Norwegian generators is the high voltage of generation in some of the older plants. The general adoption in Scandinavia of generating tensions of 9,000 to 12,500 volts preceded the largest part of the American development toward high generation voltages. The Trollhattan hydro-electric plant in Sweden, which has exerted so great an influence on the Norwegian practice, as well as on water-power development in other parts of the world, began operation in 1910 with a generating voltage of 10,000 to 11,000. In Norway the Tyssedal plant generates at 12,500, the Rjukan Saaheim plant at 9,500, the Bjölve plant at 12,300, the Solbergfos plant at 10,500, the Dale plant at 11,500 and the Samnanger plant at 7,500 volts.

Three-Phase Current Used

Three-phase generation is practically universal except in the plants serving single-phase current for railway traction. The frequency used for lighting and commercial power supply is 50 cycles per second, except some of the electro-chemical and electro-metallurgical industries where a frequency of 25 is employed. For the electrified railways a frequency of 15, with a trolley tension of 15,000 volts, has been adopted, although for two of the older lines, where a start was made with 16⅔ cycles, the original frequency is retained. Separately driven exciters are to be seen in some of the plants, but the majority are mounted directly on the mainshaft.

The transmission distances in Norway are relatively short. The line from Askim to Christiania is 30 miles long, at a voltage of 60,000; from Raanaasfos to Christiania 27 miles, at 46,000; from Rjukan to Christiania about 90 miles, at 100,000; from Bjölve to Bergen 50 miles, at 45,000; from Dale to Bergen 28 miles at 80,000; and the supply of energy for the Ofot Railway comes from the Porjus plant, which is located above the Arctic Circle in Sweden, at a voltage of 80,000 over a distance somewhat more than 155 miles.

Five hundred feet is a common mean distance for the spacing of steel towers. Wooden poles are employed on many of the farm and village lower-tension transmission lines. The rugged character of the western part of the country makes it uneconomical to build the high-tension lines "as the crow flies," and some of the lines present rather tortuous paths. Aluminum as well as copper is used for the conductors. A large part of the 100,000-volt line from Rjukan to Christiania is composed of aluminum cable containing a steel core wire. Pin insulators are used for as high as the 66,000-volt lines, and suspension insulators are employed on lines down to approximately 45,000 volts.

Present Trend in Heat Balance

A valuable review of the present trend in heat balance as applied to central stations is given in the Power Station Heat Balance Report of the Prime Movers Committee, recently issued by the N.E.L.A.

According to this report the year 1923 has been marked by the general introduction of stage bleeding by plants under construction. In the more recent plants equipped with high boilers only, heating is generally from two levels, but in some cases from as high as four levels, whereas in plants equipped with economizers the feed water, usually entering the economizer at 210 deg., is heated to this point by single or double level extraction.

With the introduction of stage heaters it has become more common to work in evaporators in such a manner that they will not increase the heat requirements of a station. The greater the number of levels at which the main unit is bled, the more difficult it becomes and the greater the increase in the cost of evaporators.

This is also true of deaërators, which are being installed in connection with plants equipped with steel-tube economizers. Closed condensate systems are being designed, preventing the air enrichment of the condensate. Such feed-water systems are apparently delivering condensate with an oxygen content, under the most favorable conditions, as low as 0.05 c.c. per liter. This figure cannot be obtained if the condensate pump is oversize so that it acts as an air pump part of the time, thus alternately removing air and water. With condensate having a low percentage of oxygen a simpler type of deaërator may be installed. Two manufacturers have on the market apparatus which, effectively deaërating such water, has a negligible effect on the heat balance of the plant. Under the earlier systems a temperature difference of as much as 25 or 30 deg. occurred in the deaërators, and the amount of steam that could be extracted from the main unit was reduced accordingly.

The types of deaërators that are being proposed when a low heat head is required are not so well adapted to operation at low temperatures of condensate as the earlier types proposed. Practically all modern plants, however, put feed water into the steel tube economizer at a temperature of approximately 210 deg. F., and in several cases it is higher than this.

There seems to be a tendency to install auxiliary generators, direct connected to the shaft of the main unit. Heating the feed water by extracting steam from the main unit has caused a change in the type of house turbine installed. The tendency now is to install the house turbine for emergency supply, or for carrying a few of the auxiliaries which would be required to maintain station service in case of interruption to the main supply, or for operation under conditions when the maximum capacity of the station is required. Practically all units of 20,000 kw. and larger are supplied with duplicate auxiliaries.

The use of steam-driven auxiliaries is decreasing, although practically all plants install and depend on steam-driven boiler-feed pumps.

Brunner High-Pressure Turbine Shows Improved Economy

Steam velocities below those of the usual practice are among the refinements contributing to an efficiency, when non-condensing, comparable with the unaflow engine.

THE steam turbine is generally credited with being less efficient than the steam engine when exhausting at or above atmospheric pressure. While this is undoubtedly true for small or medium-sized units, yet the high-pressure stages of modern central-station turbines, although of larger capacities than commercial unaflow engines, are in many instances on an equality with the latter with regard to efficiencies when compared with the reciprocating prime movers now in operation.

Another statement frequently accepted, which, however, is subject to qualification, is that efficiencies at the high-pressure end of commercial condensing turbines are inferior to those of low pressure. This also may be true for the average small or medium-sized unit, but does not necessarily hold for those of the present large capacities. For instance, the calculated efficiencies of the high- and low-pressure cylinders of the 40,000-kw. compound reaction machine described in the June 24, 1924, issue show that the curves for both high- and low-pressure cylinders are not only quite close to each other, but in reality that efficiencies of the high-pressure end throughout the load range are slightly above those of the low. This turbine utilizes steam at 265 lb. gage. It is expected, however, that efficiencies of high-pressure stages of large-sized units of commercial design utilizing steam at 500 to 1,500 lb. will be appreciably lower than that for the remainder of the turbine as mentioned in the paper read by F. Hodgkinson at the World's Power Conference. The significance of an efficiency around 80 per cent for a 2,400-kw. non-condensing turbine, two of which, Fig. 1, are installed at the Nestomitz Sugar Refinery, Nestomitz, Bohemia, built by the Erste Brunner Machinenfabriks Gesellshaft,[1] can perhaps best be expressed by quoting a statement of Dr. Stodola:

> A thermal efficiency of approximately 82 per cent at full load, between the throttle valve and the coupling must be recognized as a most creditable performance, which is in many respects of widespread importance. The steam turbine operating against a back pressure is now the equal of the steam engine. The installation at the Nestomitz Sugar Refinery sets an example and serves to indicate how the achieved progress may be further utilized to advantage. These turbines are connected in parallel to an electric transmission system, into which the surplus power may be delivered and disposed of under such favorable terms that not even the most efficient turbine in an isolated plant could compete. There is little doubt that industrial plants, with the further addition of steam storage, will take full advantage of this new source of revenue. A wide field of enterprise awaits development by well-organized and established industries. It is also known that the Erste Brunner Machinenfabriks Gesellschaft is about to apply the new principle of design to condensing turbines.
>
> In consideration of the present fuel situation, which makes it imperative to extract the maximum amount of energy, the new turbine, in spite of its higher initial cost, represents an economic progress. It will serve as an incentive toward the further development of the steam turbine.

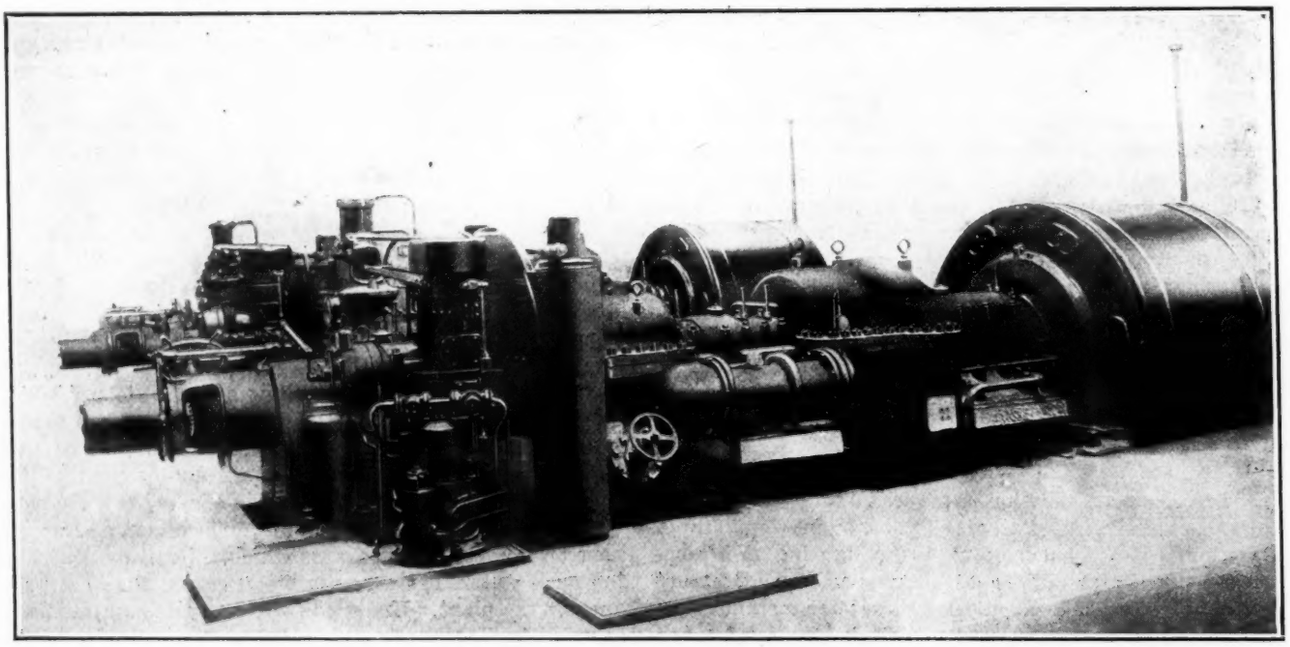


Fig. 1—Tandem compound 3,000-r.p.m 2,400-kw. units for 200 lb. abs., 750 deg. F. steam expanded to 22 lb. abs.

Low steam velocity is an important consideration in obtaining high economy. It ordinarily holds that the slower the motion of steam or other fluids through pipes,

[1] Of Brunn, Czechoslovakia.

turbine blades or other passages, the smaller will be the relative friction. Low velocities, however, mean more material and higher costs. Franz Losel, the designer of the Brunner turbine, claims in one of his patents that by arranging the turbine so that the steam travels through blades about 100 meters per second, not exceeding 140 (approximately at 328, and not over 459 ft. per sec.) relative to the blades, it is possible to obtain efficiencies considerably higher than those heretofore achieved at greater relative velocities, and better than would be expected from previous experience.

The relations of steam speeds to blade speeds are taken up in the Sept. 16 issue. If, in a single-row stage a stationary nozzle supplies steam for a single row of moving blades, the steam must be delivered by the nozzles at approximately twice blade speed. Thus if the blades move at 350 ft. per sec. at their mean diameter, steam must travel at about 700 ft. per sec. (usually somewhat faster) as delivered from the nozzle and as measured from a stationary point. The steam jet will thus actually move about 350 ft. per sec. faster than the vanes. In the Brunner turbine steam entering and passing through impulse blades is limited to a speed of about 328, not to exceed 459 ft. per sec. faster than the blades themselves.

The sections of the high-pressure units, Figs. 2 and 3,[1] indicate plainly single-row disk-wheel type turbines wherein a number of wheels containing single bucket rows rotate at comparatively low blade speed. Such low velocities as a means of high efficiency appear consistent from the fact that tests by the British Electrical and Allied Manufacturers' Association indicated that with various forms of converging nozzles, efficient peaks were noticeable around 330 to 460 and also 1,300 to 1,480 ft. per sec. relative steam velocity.

However, there exists only a difference in efficiency of about 3 per cent between the low-velocity and the high-velocity peaks indicated in the nozzle tests, which would differ somewhat from results in an actual turbine. As much as 10 per cent in efficiency and over appears to be obtained in this turbine utilizing the lower velocities. It is to be expected, therefore, that refinements of design, details and workmanship also play important parts in reaching the relatively high efficiencies shown in the tests of the Brunner 2,400-kw. non-condensing unit.

The figures indicate rigid-type rotors in which the disks are forged solid with the shafts and operated with comparatively small clearances, both radial and axial. Furthermore, it is evident that for some special reason

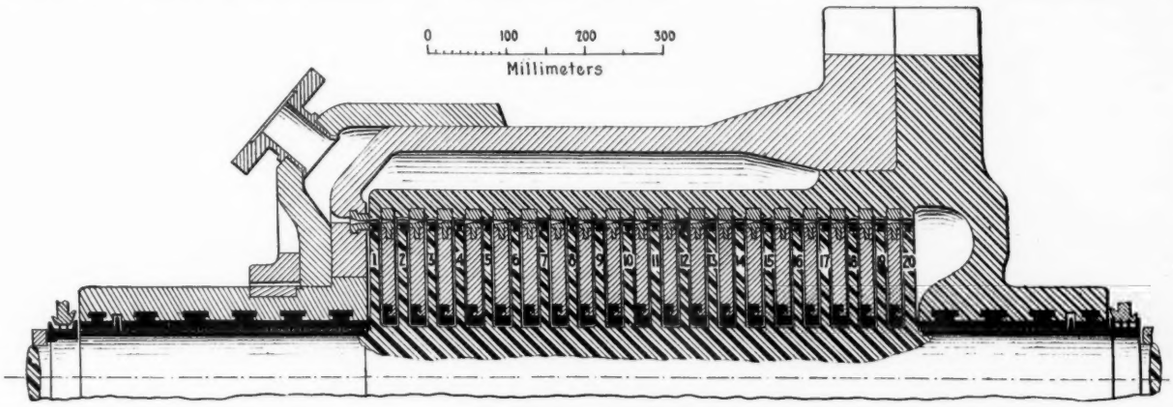


Fig. 2—Internal cylinder of unit for 1,500 lb. steam contains diaphragms with uniform nozzle diameters

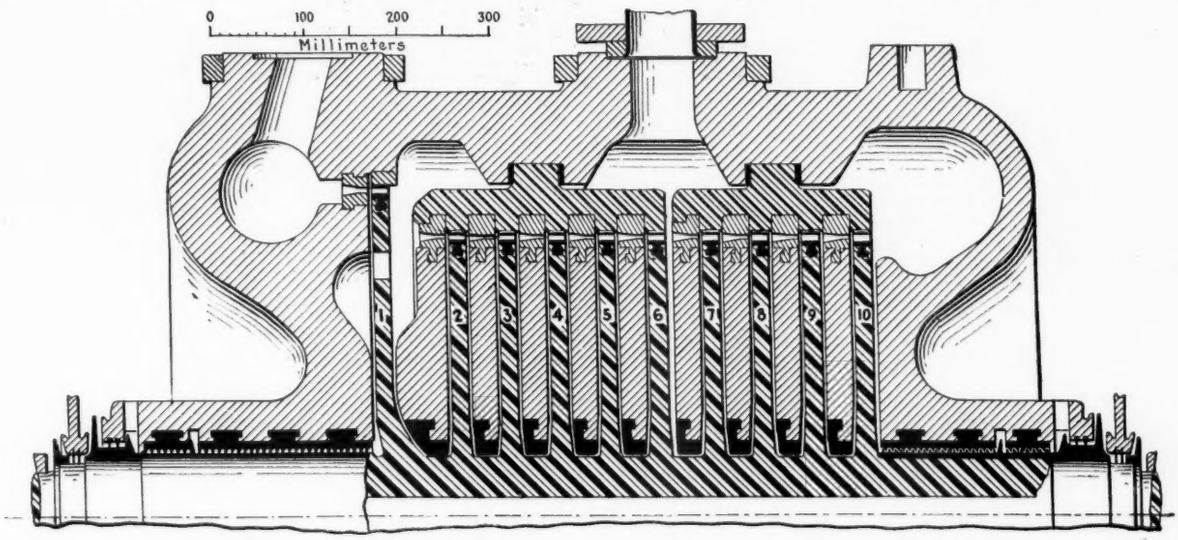


Fig. 3—General type of turbine elements as utilized in units of Fig. 1, with close clearances and solid forged rotor

[1] Published in the *Zeitschrift des Vereines Deutscher Ingeneure.*

the blade rows generally are of equal mean diameter. This latter condition is explained in a paper by C. F. Stork, read at the World's Power Conference. Tests by the manufacturer of this turbine indicate that appreciable loss is experienced in turbines built with a steadily increasing diameter from one stage to the other. Thus, diaphragm nozzles which flare out radially induce pulsations in the steam flow and hence increase nozzle loss especially with dense steam.

A worth-while gain is effected by providing carefully designed and machined stationary nozzles, utilizing the same diameter of blade rings for a number of expansions and thus avoiding surging in the steam flow. These guide blades are carefully machined and then gaged and finished by hand, to conform with the most efficient shapes established by investigation.

The turbine in Fig. 2 is designed for 3,000 r.p.m., 1,500 lb., exhausting at a high back pressure. That of Fig. 3 is for 3,000 r.p.m., approximately 200 lb. abs., exhausting at a back pressure, that represents closely both cylinders in Fig. 1. Full peripheral admission is secured for the first stage. Where maximum economy is desired, this familiar feature of supplying nozzles around the entire circumference of the first wheel so that all buckets receive steam, contributes to better efficiency than that obtained where only part of the blading area is utilized, as idle vanes produce additional friction when rotating in dead steam.

Small clearances between wheels and diaphragms apparently are so important that these seem to have been minimized as far as consistent with good operation. Radial blade clearances are notably less than would be expected in an American impulse turbine. In order to secure uniform expansion, the diaphragms are held by internal cylinders surrounded, as especially

SOME RESULTS OF TESTS BY PROF. A. STODOLA AND OTHERS, JULY 3 AND 4, 1923, AFTER ONE YEAR'S OPERATION, ON THE 2,400-KW., 3,000-R.P.M., NON-CONDENSING UNIT

Original quantities in C. G. S. units have been converted to English units.

	Full Load	Half Load
Kilowatts	2,325	967
Steam press, at throttle, lb. abs.	202	198.5
Steam press. h.p. nozzles, lb. abs.	196	127
Steam press. between cylinders, lb. abs.	79.5	21.47
Back press. at turbine, outlet, lb. abs.	22.16	22.15
Steam temp. at throttle (average), deg. F.	741	718
Steam temp. at h.p. nozzles (therm. No. 1), deg. F.	743	714
Steam temp. at h.p. nozzles (therm. No. 2), deg. F.	736	708
Mean nozzle temperature, deg. F.	739	710
Steam temp. at h.p outlet, deg. F.	545	502
Steam temp. at l.p turbine outlet, deg. F.	325	370
Steam consumption, lb. per kw.-hr. referred to generator output	19.4	26.3
Steam consumption, lb. per kw.-hr. referred to output at coupling	18.45	23.9
Thermal efficiency referred to generator output, per cent	12.60	9.45
Thermal efficiency referred to output at coupling, per cent	13.24	10.31
Turbine efficiency calculated from heat drop at throttle, per cent	85	71.1
Turbine efficiency calculated from heat drop at hp nozzles, per cent	85.6	84.5
Turbine efficiency of h.p. cylinder, per cent	84.6	82.8
Turbine efficiency of intermediate cylinder, per cent	83.4	83.7
Efficiency of turbine, referred to output at coupling and available heat drop at throttle, per cent	82.0	65.1
Efficiency of turbine generator unit referred to generator output and available heat at throttle, per cent	77.9	59.2

noticeable in the high pressure unit, Fig. 2, by steam admitted from the first expansion stage relative to the blade ring. The rigid rotor is a necessity in maintaining the close clearances, as the tendency to vibrate is thus minimized. The diaphragm packing consists of labyrinth rings, and this type is also used at each end of each cylinder.

It would appear therefore, that the application of closer clearance both radial and axial, than common in this country is a large factor in obtaining the improved economy. In order to make this possible a rigid-type rotor is utilized, together with special construction to secure uniform expansion of the internal cylinders containing the diaphragms. Hand-worked parts of high polish and accurate form are recognized as largely responsible for high economy obtained in European makes of turbines.

The Brunner machine, as stated by the builders, possesses one remarkable characteristic; as initial pressures are raised, the efficiency of the high-pressure element also increases. It will be seen from tests in the table that the high-pressure element receiving 200 lb. steam is slightly higher in efficiency than the low. If, instead

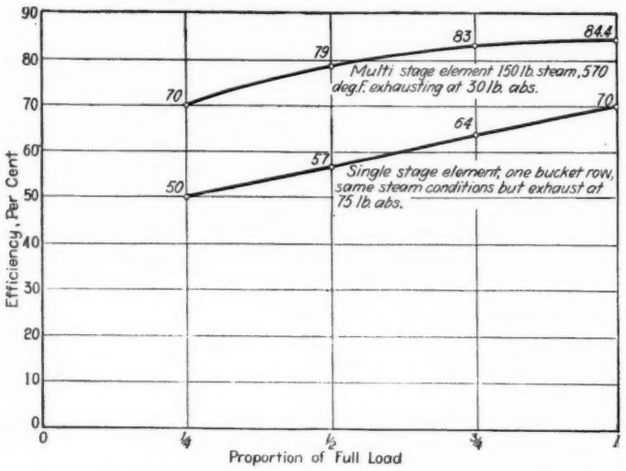


Fig. 4—Comparing efficiencies of Brunner turbine with that of a single-row stage

of 200, the units were designed for 1,500 lb., the high-pressure cylinder efficiency for an equal capacity would be upward of 5 per cent better. This is due to special features to be made public at a later date.

Stresses are held so as not to exceed 7,000 to 9,000 lb. per sq.in. In the design of the high-pressure elements the last row of blading is limited to that length which will not exceed these stresses. For the remainder of the expansion, after leaving the high-pressure cylinder, a second disk-wheel element is provided.

In Fig. 1 appears two of the 2,400-kw. 3,000-r.p.m. tandem-compound turbines, each consisting of two impulse cylinders with a thrust bearing placed between. Both cylinders are of the same general cross-section as that in Fig. 3. Steam at 200 lb. abs., 740 deg. F. total temperature is expanded to a back pressure of approximately 22 lb. An abstract of tests on one of these units by Professor Stodola and others is given in the table. These tests were made July 3 and 4, 1923, after one year's operation.

The flatness of the efficiency curve is apparent from this table and also from the curves in Fig. 4, representing tests on a multi-stage high-pressure element, operating between pressures of 150 and 30 lb. abs., as compared with those on one single-row stage at a pressure range of 150 to 75 lb. abs.

Smaller units of the Brunner turbine, mentioned by C. F. Stork as being built in Holland under license, are a 750-kw. turbine, 103 lb. per sq.in., 617 deg. F., exhausting against 10 lb. per sq.in. gage with an over-all turbine efficiency of 77 per cent, normal load, expected to be 80 to 85 on an overload. Also a 16,000-kw. 500-lb. 750-deg. F. steam condensing unit with a guaranteed efficiency of 86 per cent for the turbine, is under construction.

Keeping the Heating System Warm at Night

WHERE steam from central stations or other sources is constantly available the tendency in general is to keep the radiation warm at night, so that a comfortable temperature will be provided in the morning. Radiators in office buildings with individual control are frequently left open at night through the negligence of the occupants. Recent studies of steam-heating systems have shown that a tremendous waste is ordinarily thus produced while impressive economies have, in some instances, been effected largely by limiting the steam utilized at night. Systems of this kind ordinarily arrange for the steam to be turned off totally either during one long period or for several shorter intervals during the night. Economies effected in the heating system are often reflected indirectly in returns to the central station. Gain by such means would be an incentive to the adoption of rigid measures for the sake of economy.

While desirable savings have been made by a total closure of the steam supply during the night time, with an interval of heating up in the morning, a study of the application of steam heating indicates that there are many instances where a constant supply of steam during the night, if properly proportioned, would be preferred to total closure.

One objection to closing off the steam and then heating up rapidly is that the radiators are frequently worked at higher temperatures than normal during the heating up intervals and excessive losses, due to the high temperature of the returns, occur. Another objection is that in very cold weather the entire heating system is subjected to rapid expansion during the warming up period, which tends to deteriorate the joints and perhaps other elements of the system. There is in all probability some undesirable expansion effect in steel buildings due to rapid internal heating, although this matter has apparently not received special attention or investigation. For these reason a small amount of steam sufficient to keep the risers and part of the system slightly warm would appear to be an advantage.

In some instances provision has been made for a very small amount of steam to be admitted during the cool interval. A question that may occur when steam is admitted for the purpose of heating the risers, is whether these are heated uniformly or not. In order to derive full benefit from the admission of a small amount of steam, the system should be so designed that risers close to the supply do not receive more steam relatively than risers situated at a distance. Systems controlled from a central point may be readily adapted to distribute uniformly a small amount of heating steam as well as the maximum amount admitted during the heating up period in the morning.

It may sometimes be advisable to supply heating steam at night in a comparatively generous quantity, owing to considerations other than those of interior temperature. Where a small boiler plant is, in addition to heating requirements, arranged to supply steam for emergency apparatus, such as a fire pump, it will be in better condition to respond to a sudden demand than if little or no heating steam were being generated. In the latter instance fires may be banked to a considerable extent, while in the former arrangements could be made so that the steaming rate would require a fairly active fire and if necessary, steam could be shut off from the heating system, thus giving an immediate flow for emergency operation.

Getting Ideas Across

IT OFTEN happens that those very qualities and acquired traits that enable the engineer to succeed as an engineer are a hindrance in other ways. The engineer learns to concentrate, specialize and analyze, paying more attention to fact than to the spectacular. The very nature of his work tends to make him cautious, reserved and modest. He is the reverse of the salesman; and he deliberately shuns those attributes, inherent and assumed, that are so largely the salesman's stock in trade.

This may explain why the engineer so often fails to "put over" an idea that has everything to recommend it except adequate salesmanship. There are engineers, sales engineers and salesmen. The average engineer might with advantage to all know a little more about salesmanship and the psychology back of it. By so doing he will also obtain a better understanding of the higher executive's viewpoint and his mode of reasoning.

Perhaps the greatest contrast between the engineer and the executive is that the engineer thinks of equipment in terms of performance, while the executive looks upon results mostly in terms of dollars and cents. The engineer is chiefly concerned with accomplishing a given purpose, rather than what that purpose is intended ultimately to achieve. The executive is vitally interested in the final accomplishment. To him, machines, materials, men and methods are merely tools toward an end.

This probably explains why so many engineers fail to obtain the equipment they want. The salesman, of course, in final analysis, places his argument or plea upon a dollar-and-cent basis.

One quickly grasps the difference between an advertising manager's report and the engineer's report. The advertising man comes out on the top line with the dollar-and-cent savings. The engineer devotes pages to his hypothesis, how he made the tests, and gives the results in a few modest lines at the end. If the engineer would put his last few lines, or summary of results, at the top of the front page, he would more

often succeed in getting the equipment he so badly needs.

What holds true in getting approval of recommendations for new equipment also holds true in another important phase of selling, that is, selling yourself. The engineer who can show what he saved in the way of lower fuel bills, lower upkeep cost, etc., is the man most likely to get a raise in pay, whether solicited or unsolicited. The report sheets of many power houses bear eloquent but buried testimony to the engineer's ability. But until this information is taken out and placed upon a dollar-and-cent basis and presented in a way that stresses its achievement, those men whose minds are occupied with other matters cannot be expected to appreciate their significance. Therefore, every engineer should study salesmanship, that he may obtain the equipment he needs and the remuneration he deserves.

At the N.A.S.E. Convention

TWO weeks ago we commented favorably upon the program of technical papers arranged for the Grand Rapids Convention of the N.A.S.E. and ventured a suggestion that the support accorded the Papers Committee in this step would indicate the seriousness of the Association in this direction.

The convention is now over. It was a good convention, judged from past standards, but it was very evident that the Technical Papers Committee did not receive the backing to which it was entitled and which its efforts warranted. It is not only discourteous but an injustice to expect speakers after paying their own expenses and giving up valuable time from their office duties, to pace the convention hall for days awaiting the call of the chairman during some lull in the business discussions; and then to have two-thirds of the audience file out before the paper is started. Technical papers should not be regarded as "fill-in acts"; they deserve and have a right to a place on the regular program at which sessions those interested can plan to attend. Doubtless the committee will experience some embarrassment in filling its program another year.

Much spirited discussion took place on the convention floor regarding the educational activities. Some were in favor of establishing a centralized information service to the members, while others believed that the educational ideals of the association should furnish the necessary stimulus to encourage individual and local effort, citing in proof the standing of many of the members in the engineering profession.

Which of these courses to pursue is a matter for the membership to decide. We venture no opinion. The fact remains, however, that all is not well with the educational work as is evidenced by the undercurrent of dissatisfaction culminating in the discussion.

There is open, however, one concrete way in which the Association can add to its prestige and make its conventions of greater service to both the delegates and the members at home. Print the technical papers in advance, invite discussion and set aside definite sessions for the presentation of papers and the discussions. It will stimulate interest both within and without the Association. Other societies have found this the only way and have doubled and trebled their membership as a result, whereas the membership of the N.A.S.E. has remained at practically the same figure for years.

Efficient Use of Steam at Higher Pressures

AFTER the lessons of operating at maximum pressures have been learned, they will doubtlessly be applied in the design of such units for greater efficiency.

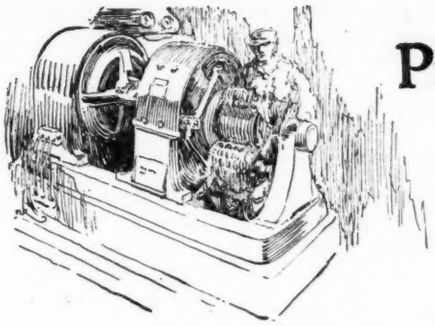
Although general information about the physical properties of steam at such pressures is appreciably incomplete, we do know that it is necessary to deal with a fluid of much greater density than at the usual pressure ranges. Saturated steam is about five times as heavy per cubic foot at fifteen hundred pounds as steam at three hundred pounds. Generally speaking, denser fluids produce greater friction losses relatively, and for reasonable efficiency must ordinarily be operated at slower speeds.

Turbine elements for the extreme of pressures are in many cases designed as velocity-stage machines where two rows of revolving buckets utilize the steam speed obtained by a single expansion. As to reliability, this represents a rigid construction and gives the lowest possible pressures for which the shaft glands must be packed. From the point of view of efficiency, however, it is inferior to utilizing a number of expansions over the same pressure range, where the steam, as delivered to the blades, exceeds them in speed by as small a margin as consistent.

Elsewhere in this issue is described a foreign type of high-pressure turbine, designed to suit commercial considerations that make a highly efficient mechanism profitable. Little information regarding details of the construction has been given out. Means of packing against the higher pressures in the first stage are entirely lacking. On the other hand, this is known to be the Rateau multi-pressure stage type of machine, where disk diameters are kept to a minimum, and slow steam speeds are featured.

Information indicates that the builders also have utilized to advantage another source of loss. Steam leaving a turbine blade has a certain amount of velocity in an axial direction. In other words, it leaves the blade at an angle, and although the speed in the plane of rotation may be close to zero, the speed in an axial direction, causing the opening of the angle, is an appreciable amount and represents loss, unless it can be utilized. With higher-pressure steam this loss is accentuated. By carefully arranging the stationary nozzles or redirecting blades so as to catch this discharge steam, and gradually curve it in the direction required for the next bucket, this loss may be obviated to a large extent.

As may be judged from the two-page report in this issue, last week's convention of the Association of Iron and Steel Electrical Engineers was a real success. The environment of the steel industry, where everything is measured in terms of quantity, quality and unit cost of the product, is peculiarly favorable to the development of practical men. The situation created by the breakdown of a rolling-mill drive, for example, is altogether too real to be handled by well-chosen words. Nothing but deeds counts at such a time. It is but natural that an organization composed of the graduates of such a school should be notable for its ability to get down to brass tacks. When, in addition, the members are equipped with a good measure of technical skill, as is the case with the A. I. & S. E. E., a distinguished position among engineering societies is assured.



Practical Ideas *from* Practical Men

Boiler-Repair Records

One of the most important factors in the proper maintenance of a boiler plant is the keeping of an easily accessible and accurate record of cleanings, repairs and inspections. The card-index system outlined herewith

	BOILER NO. 13	Cut out
	Turbine all tubes	
	Repair all leaky valves	
	Make necessary repairs to furnace and setting	
	Scrape drums and feed pan	
	Repair No. 4 soot blower	
	Clean dry pipe	
	Overhaul burners	
	Examine tubes and report any defects	
	Make external inspection and cold-water test	
	13 d	Cut in

Fig. 1—Card showing work to be done on boiler

has been found efficient and reliable in a 10,000 hp. plant and has many advantages over a boiler-repair book.

When a boiler is taken out of service, a 5x8-in. card made out as shown in Fig. 1, is tacked to the bulletin board and the work indicated on it assigned to the various men in the crew. As soon as each job is completed, the man who did the work initials and dates

	BOILER NO. 13	Cut out	8/13
	Turbine all tubes		
M.C.	Repair all leaky valves		8/14
J.D.	Make necessary repairs to furnace and setting	OK	8-19
J.N.	Scrape drums and feed pan		8/16
M.B.	Repair No. 4 soot blower		8/15
W.T.	Clean dry pipe		8-17
J.D.	Overhaul burners		8-20
J.H.	Examine tubes and report any defects	OK	8-20
E.B.	Make external inspection and cold-water test	OK	8-20
	Completely inspected by Insurance Inspector Smith no defects noted 8-20-24		
	Found at 2 P.M. 8/21		
	13 d	Cut in	8/21

Fig. 2—Card is initialed and dated by man doing the work

opposite the item. Thus the engineer may by a glance learn the progress of the work at any time. Also, should any carelessness cause trouble later, the workman responsible can be singled out.

The card is returned to the office looking something like that shown in Fig. 2 and is filed in a drawer of the filing case reserved for that particular boiler. Each boiler has a master or index card filled out like that shown in Fig. 3, from which the length of time the boiler has been in service and other information may

BOILER NO. 13 1924

Cut in	Out out	Card	Tubes	Furnace	Remarks
12/20/23	5/16	a	Retubed	Rebuilt	
5/4	5/12	b	"		New blowoff line
5/28	7/4	c	"		Renewed one tube
7/13	8/13	d	"		Insurance inspection
8/14					

Fig. 3—Master or index card shows time boiler has been in service and other details

be obtained without looking through the individual cards, one of which is made out for each time the boiler is taken off the header.

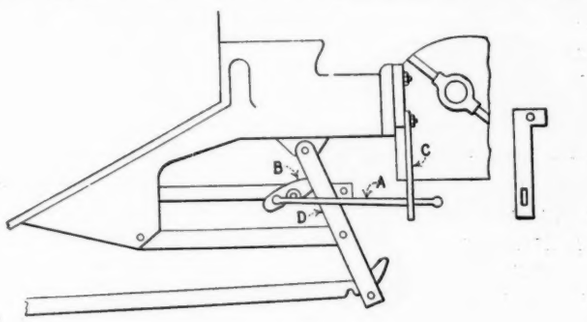
C. L. ORR.

Gulf, Texas.

A Long-Stroke Control for an Underfeed Stoker

A device for controlling the long stroke of the Taylor stoker has been devised in a certain steam plant where a number of these stokers are installed.

The apparatus consists of a light lever connected to



Details of controlling lever

the long-stroke stop and extending toward the front of the stoker. A support for this lever is attached to the power-box frame. The controlling lever *A* is supplied with a notch in such a location that when the lever is shoved forward with the long stroke in the outward position, the long-stroke stop *B* is forced up into the

engaging position and held there by the notch in the lever catching on the inside of the supporting bar *C* attached to the power-box frame. As the ram is forced in, the lever *D* engages with the long-stroke stop so as to force the ram for the full travel. As soon as the return stroke starts, the long-stroke stop is released and falls into the disengaging position. As the lower ram is drawn outward to the limit, the notch in the controlling lever engages and forces again the long-stroke stop into the engaging position ready for the next stroke.

ALLAN P. CHILD.

Kansas City, Mo.

Starting 220-Volt Induction Motor with a 110-Volt Compensator

A reactance or choke coil may be used to reduce the voltage for starting an alternating-current motor in a manner similar to an auto-transformer. With the choke coils in circuit the current supplied to the motor is the same as the current taken from the line, just as when using a resistance. With an auto-transformer, current at line voltage is transformed into a current at lower voltage so that the motor current may be considerably larger than the line current. For example, on a 70 per cent voltage tap on the compensator the line current will be about 75 per cent of that supplied to the motor.

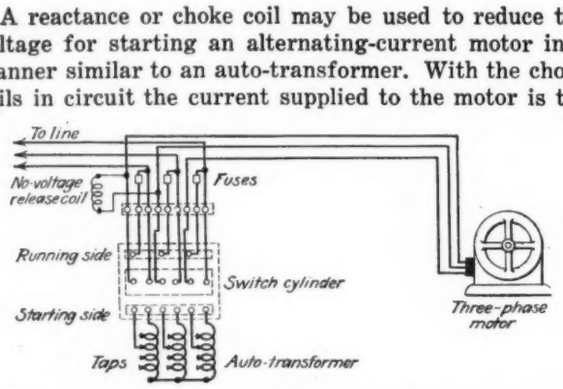


Fig. 1—Original connections of 110-volt starting compensator

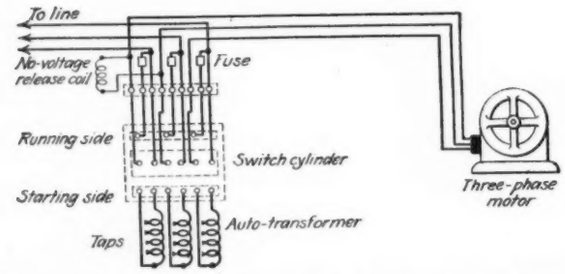


Fig. 2—Connections of 110-volt compensator changed for use on 220-volt service

Recently, I had a case where the compensator was burned out on a 15-hp. 220-volt motor. It was necessary that the motor be put back into service as soon as possible, and some provisions had to be made for starting the motor. There happened to be available a 110-volt compensator, connected as in Fig. 1. It was considered that this could not be used as an auto-transformer on 220 volts, so the connections were changed to those shown in Fig. 2, and satisfactory starting was obtained until the original starter was repaired. In Fig. 2 each coil of the auto-transformer is connected in series with the motor at starting and acts as a reactance or choke coil in the line. In cases where sufficient current cannot be obtained to start the motor in this way, the highest voltage tap can be tried and the connections made as in Fig. 1.

Philadelphia, Pa. A. A. FREDERICKS.

Operating Steam-Turbine Generators

The generators of several 1,875-kva. 3,600-r.p.m. 480-volt turbine units in our plant are ventilated by means of air drawn in through ventilating ducts by the action of fans attached to the ends of the generator rotor. Air is forced out through the stator windings and then carried to the exit ducts through passages in the generator casings. Ventilating air for each generator must be clean, cool and free from moisture, oil vapor and dust or other foreign matter, in order that the generator windings may be kept at the proper temperature, as well as clean and free from carbonized oil, dirt, grit, etc. The axial clearances between ventilating fans and air shield rings are maintained at $\frac{3}{16}$ in. at the turbine end of the rotor, and at $\frac{1}{4}$ in. at the collector ring end. The steel rings inclosing the end windings of the revolving fields are shrunk on and may be removed by heating to approximately 150 deg. C.

Forged copper collector rings rotate against the thin edge or acute angle of the slanting brushes. A brush compression of $1\frac{1}{2}$ lb. per sq.in. of cross-section is used, no lubricant being applied to the collector rings. They are maintained smooth and true by being turned down in place at periods of six months, with a rig and cutting tool attachable to the machine.

Every three months the generator air shields and lagging are removed and the armature and field structure thoroughly blown out with compressed air. Any greasy dirt is removed with gasoline, and all insulation surfaces are painted with air-drying insulating varnish.

Load on the three generator phases is kept as nearly balanced as conditions will permit, and in no case is the current in any one phase allowed to exceed that in any other by more than 15 per cent of the full load current. The unbalancing of phase loads is undesirable for the reason that this may cause disastrous inductive effects with resulting grounds or burnouts in the revolving field windings. Such a condition may also produce mechanical unbalance and severe strains on the shaft and bearings, besides overheating of the entire unit.

Shortly after these machines were put into operation, it was noticed that a considerable amount of induced current was being generated in the mainshafts which flowed to ground through the journals and bearings. Lightly bearing copper brushes were installed on each shaft by means of which this current was conducted to the machine frames and thence to ground, after which a decided improvement was noticed in bearing operation.

CLAUDE C. BROWN.

Los Angeles, Calif.

When a vacuum heating system begins to lose its vacuum, it is not necessarily the fault of the vacuum pump. See if an oversupply of steam is not being used, by throttling the steam entering the system, until the return pipes become lower in temperature. The vacuum should then reach normal if the pump is all right.

The early De Laval high-speed, single-stage turbines, operating with an extremely flexible shaft, were designed to run at about seven times the critical speed.

Comments from Readers

Mouth-of-Mine Power Plants

The editorial in the Aug. 26 issue on "Mouth-of-Mine Power Plants" presents an aspect of it that, while, it has been considered, has not been widely advertised and it is not in my opinion a solution of the problem. The deciding factor in many present-day problems in power generation and distribution, whether hydro or steam power, mine mouth or load center, plant location, etc., is a commercial rather than a purely technical one. According to what little information has been published on large generating and distribution systems, fixed charges comprise somewhat more than half the cost of power, and of these about one half are chargeable to the distribution system. Of operating costs fuel seems to amount to 60 to 80 per cent, so, while it may be possible, by partly eliminating freight charges, to hold this part of the cost reasonably constant, the fixed charges on the transmission system to handle all this power to the load-consuming center will increase the cost substantially.

There are some other less important considerations which, while they may not be considered by power experts, are of pretty serious interest to the man who is trying to maintain a normal load factor and costs, the year round. For instance, locations such as Seward or Springdale, where coal can be handled direct from mine over the company's own system to the plant, are exceptional, and most of the so-called mine-mouth plants—for example, Saxton—must pay around 80c. to $1 per ton freight, compared with a rate of $2.74 to tidewater at New York, in order to get the coal where even small streams of water are available. Strikes in the bituminous coal fields are by no means unknown, and there is no reason to believe that the union will hesitate to shut down the plant-owned mine as readily as any other. In such case the haul from a distant field, or of imported coal, is likely to be quite expensive.

Practically all streams in the coal fields are badly polluted with mine water, and this situation is increasingly serious in dry seasons, as owing to disturbance of the strata in mining more of the water tends to find its way into the mines and less to the surface springs, so that there is less and less dilution of the sulphuric-acid content. Satisfactory treatment of such water is expensive, as it leaves too much soluble salts for high-capacity operation and the alternative of operating surface condensers with distilled makeup and treated circulating water over a cooling tower will reduce the vacuum below the economical point. Furthermore, what guarantee has the operator that, as in the summers of 1922 and 1923 in the Pennsylvania mountains or at present in the hydro-electric district of California, the water supply will not fall below previous records to such an extent as to curtail operation seriously?

It has recently been said in an A.S.M.E. discussion that a hydro-electric installation costing over $200 to $250 per kilowatt could not compete with a modern steam plant, so if this is the case it is difficult to see how a mine-mouth plant carrying practically the full operating cost of a load-center steam plant, owing to the considerably increased consumption of coal at the lower price, can shoulder the fixed charges of the necessary transmission system and furnish service at comparable cost, considering the incidental difficulties mentioned in the foregoing. H. D. FISHER.

New Haven, Conn.

Speed Regulation of Underfeed Stokers

It seems that equipment such as a stoker-speed regulator should not be purchased without making a study to show how the required saving is to be accomplished. As many stations are now about to decide whether or not to install such regulators, it is thought that the discussion started by my communication in the July 1, 1924, issue might be profitably continued.

I have met many who favor stoker-speed regulation but can give only vague answers to the question of just what the regulators will do. They have laid most stress on the fact that it seems ideal to proportion the coal-feed rate to the air-flow rate. Some of the advocates have claimed that the CO_2 percentage would be almost immediately reduced in the boiler gases if the stoker speed was not proportionately increased when the air-flow rate was raised. The test data given in my previous discussion were intended to disprove this theory.

I am glad to find that C. H. Smoot (in the July 29 issue) agrees that stoker-speed regulators are not necessary to prevent any fluctuation of CO_2 for periods of 30 minutes duration. This removes from consideration one of the chief arguments for these regulators.

He has clearly described the condition with manual control of an underfeed stoker. I agree that the error in speed adjustment with manual operation must have continued for such a time as to be detected by the firemen, in order to make the correction. As Mr. Smoot says, with manual control there is a continual oscillation between too little speed and too much, this being determined by the skill of the firemen. As was shown by the test results given previously, this oscillation is, so far as the effect on the ratio of coal feed and air flow are concerned, a very slow one. With an error in coal-feed rate of 25 per cent, which would be large, the operation could continue for more than an hour before the CO_2 were appreciably affected. The variation of CO_2 over five- or ten-minute intervals, which could not be caused by any relation of coal feed and air flow rates, is likely to be much greater than the average variation due to the operation for an hour with a 25 per cent error in coal feed.

The whole argument of Mr. Smoot seems to be based upon the assumption made in the second paragraph of his discussion, that when the air and fuel supply are maintained initially in their proper proportion, the

condition of the fuel bed remains as it should be for the combustion desired and becomes neither thick nor thin nor does it develop holes. Many of those who have actually fired underfeed stokers will be inclined to disagree with this viewpoint. If this were true it would only be necessary to provide manually controlled boilers with air-flow and stoker-feed indicators. Then good combustion could be obtained by the least experienced firemen if they were provided with curves showing the value of stoker feed to carry with various values of air flow.

The term "hole" is not especially applicable in describing a condition of some part of the fuel bed on an underfeed stoker through which large amounts of unconsumed oxygen enter the furnace. Although the grates of these stokers are sometimes allowed to become bare at points near the discharge end, this happens only when the operation is very poor. The CO_2 is frequently low in the gases from a fuel bed in which there are no places in the fire, that might be called "holes."

This low value of CO_2 results from part of the grate being covered with refuse having so low a percentage of combustible matter that combustion cannot continue and the oxygen in the air passing through this portion is not consumed. By increasing the horizontal motion of the fuel toward the discharge end of the stoker or by reducing the air flow through the bed, the fuel reaching these points where the air was passing through will have a higher percentage of combustible and the oxygen in the air passing will then be consumed.

Excess Air from Ashpit Combustion

If the amount of combustible matter that is pushed onto the discharge end of the stoker or into the clinker pit is too great for the value of air flow through the fuel bed at this point, the refuse will pass out of the zone of combustion before it is sufficiently reduced. When the refuse is allowed to burn out too soon, the excess air loss is increased and, if in an effort to reduce this loss, too much fuel is pushed into the clinker pit, the loss due to combustible in the ash will be increased. Regulation consists in so controlling the shape and movement of the fuel in the bed that the sum of the stack and ashpit losses will be a minimum.

As is well known to stoker operators, the condition at the discharge end of the stoker varies greatly at different points across the stoker. At one place the fuel bed may be burning out so fast that a large surface is non-incandescent, while at a point three or four feet farther along the combustible may be discharged into the pit at a rate much greater than it can be burned. To obtain the finest regulation and the highest efficiency, it is necessary for the fireman to give the greater part of his attention to changing the adjustment in the different stoker sections so as to keep the condition of the fuel bed at the discharge end as even as possible.

Suppose it were true that the only factors which affected the rate at which combustible is discharged onto the clinker plate or clinker pit of a stoker were the air-flow and coal-feed rates. Then the use of regulators which keep the coal feed proportional to the air flow would cause the proper amount of combustible to be discharged into the clinker pit, although the fuel bed would not automatically assume the proper shape unless the agitators or secondary rams and air distribution dampers were properly adjusted for the particular coal burned.

The condition of the fuel bed at the end of the stoker is affected by the differences in the kind of coal supplied to the stokers as well as by variation in the rate at which the refuse is removed from the clinker pit as well as that of the stoker adjustments and air distribution dampers. In one station in which the coal used is obtained from a single mine, the differences in the size of the fuel is sufficient to cause trouble.

It is true, as Mr. Smoot says, that manual regulation gives intermittent adjustment in the rate of fuel supply which can be made only subsequent to a definite error. This error results in the fuel at the discharge end of the stoker being, on the whole, either too much burned out or too rich in combustible. The latter cannot be burned before being carried out of the combustion zone. As stated before, these conditions result from variation in other factors as well as the amount of coal feed and air flow. To obtain the best regulation of the conditions at the end of the stoker, the ratio of coal-feed rate to air-flow rate must sometimes be varied from what Mr. Smoot calls the proper proportions, so as to correct for variations in the other factors, although the average value of air flow and coal fed over a period of time will be in the equivalent proportion.

Constant Air-Coal Ratio and CO_2 Variations

If the air flow and coal feed in an underfeed-stoker fuel bed are maintained constant at the proper ratios over a long period of time, as a day or a week, it will be found that the CO_2 will vary greatly over periods of fifteen to sixty minutes. When a continuous record of the combustible in the refuse can be obtained, it will also be found to vary.

These variations will occur even under test conditions of firing, and are due to changes of the state of the fuel bed at the end of the stoker caused by other factors than the relation of air-flow and coal-feed ratios. Different conditions of the fuel bed, as evidenced by the extent of the CO_2 variations, will be found, in my opinion, to be as great as the definite errors that would occur from the coal feed being allowed to become disproportional to the air flow, when the rate of feed was determined by observation of the fire rather than by keeping it at all times at a constant value. In fact, the variation in CO_2 could be reduced by the latter method because by changing the stoker speed with the air flow remaining constant, some of the variation in the other factors that affect the fuel bed could be corrected.

In many plants there are great variations in the kinds of fuel beds carried by the different operators. The operator on one shift may prefer a very thick fire, while the man that follows may burn the fire down very thin. The use of stoker-feed regulators in such a station would tend to prevent the fuel bed being varied by the different shifts, if the adjustment of the relation of the stoker-speed rate to air-flow rate were taken out of the hands of the firemen.

Although in this case the use of regulators would result in some improvement in efficiency, a similar or greater improvement could have been made, it would seem by properly supervising the work of the firemen. I believe that if operating results have been improved by the use of automatic regulators, it is because of

conditions that could also have been improved by better operating supervision.

The results obtained in my tests are said by Mr. Smoot to be possible only because the fuel bed was previously well conditioned. This can hardly be the case, because these tests could have been continued indefinitely with the same results. In the boiler plant where these were made, the CO_2 and combustible in the refuse is determined daily for each boiler. The sum of the ashpit and dry gas stack loss is being carried in regular operation on an average of 2 per cent of the heat in the fuel supplied, which is believed to be below the values upon which stoker guarantees are based. As no stoker-speed regulators are used in this plant, it would be interesting to know whether any station using regulators is doing so well.

In the foregoing discussion, when considering stoker regulators, it has been assumed that they would always be perfect in operation. The difficulties in keeping at least some types of these regulators in such condition that they will maintain the desired relations between stoker speed and steam or air flow is another point that must be considered.

J. E. RICHARDSON.

Pittsburgh, Pa.

Determining Fall in Pressure in Hydraulic Turbine Penstocks

Referring to the article on "Fall in Pressure in Hydraulic Turbine Penstocks Due to Acceleration of Flow," by S. Logan Kerr, published in *Power*, Aug. 12, I would like to offer some comment regarding the solution of formulas given therein, using the same nomenclature:

h = Maximum fall in pressure below normal in feet due to an increase in flow from zero;
V = Velocity in feet per second in the penstock when the gates are opened to the desired position;
L = Length of penstock in feet;
H = Effective head on the turbine in feet;
T = Time in seconds, required for the opening of the turbine gates;
g = Acceleration of gravity (32.2).

Combining the formulas for obtaining T in the original article, an expression is obtained which reads,

$$T = \frac{2LV}{gH}\left(\frac{1-\frac{h}{H}}{\left(\frac{h}{H}\right)^2}\right)^{\frac{1}{2}}$$

This equation now takes the form of one variable equals the product of two other variables and is readily solved by the nomographic chart shown in the figure. The use of the chart is extremely simple. Taking the first problem in the original article: Given H = 300 ft., L = 500 ft., V = 7 ft. per sec., and T = 1.75 sec. Required, h.

From these values $\frac{2LV}{gH} = \frac{2 \times 500 \times 7}{32.2 \times 300} = 0.724$. Then draw the straight line M intersecting at T = 1.75 and $\frac{2VL}{gH}$ = 0.724 on B and it will cut the line C giving a value of $\frac{h}{H}$ a trifle less than 0.340; therefore $h = 0.34H = 0.34 \times 300 = 102$ ft. The algebraic solution gives $\frac{h}{H} = 0.337$ and h = 101 ft.

Taking the second problem in Mr. Kerr's article. Given, H = 400; L = 1,500; V = 10.15; h = 150. Required, T.

$\frac{2LV}{gH} = \frac{2 \times 1{,}500 \times 10.15}{32.2 \times 400} = 2.36$; $\frac{h}{H} = \frac{150}{400} = 0.375$.

Draw the straight line N intersecting line C at 0.375 and line B at 2.36, then the corresponding value of T, 5 sec., is given on line A. The algebraic solution in this case gives T = 4.98.

From these two problems it appears that the chart is sufficiently accurate for all purposes, as it is generally conceded that errors of 1½ per cent to 2 per cent are to be expected in practical hydraulic problems.

Another interesting solution afforded by the chart is that occurring when h and T are known. Given the

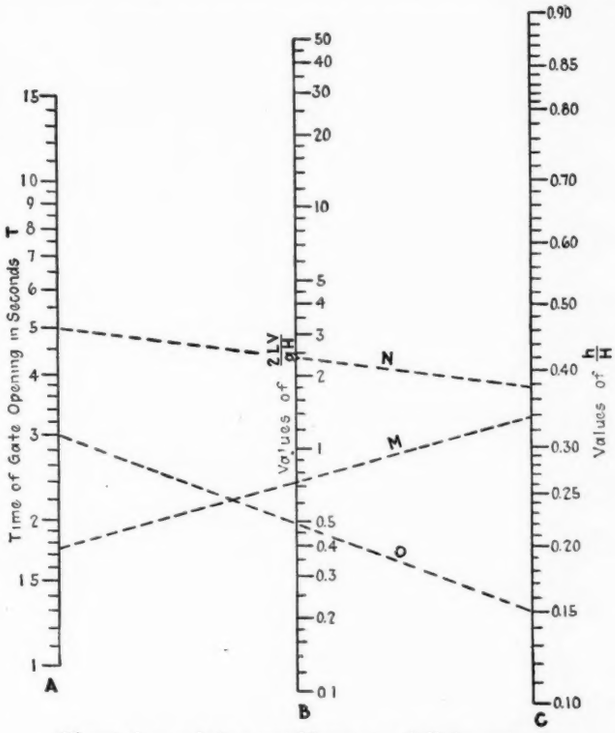


Chart for solving problems on fall in pressure in penstocks

following conditions: h = 30, T = 3, H = 200, and L = 400. Then $\frac{h}{H} = \frac{30}{200} = 0.15$. Draw the line O connecting T = 3 and $\frac{h}{H}$ = 0.15 and the value of $\frac{2LV}{gH}$ is found to be 0.49; therefore $\frac{2 \times 400 \times V}{32.2 \times 200} = 0.49$, or $V = \frac{32.2 \times 200 \times 0.49}{2 \times 400} = 3.94$ feet per second. This is the maximum allowable value of V and, if not exceeded, will limit the decrease in head to 30 ft. With this value of V determined, the size of the penstock is readily calculated.

It will be noted that for the use of the chart it is necessary to solve, algebraically, the expression $\frac{2LV}{gH}$. A nomograph could be constructed for the solution of this expression, but since $\frac{2L}{gH}$ is constant for any particuar installation, the graph would be used but once on any problem and a chart is therefore hardly necessary.

W. I. BARROWS, Hydraulic Engineer,
The Management Engineering & Development Co.
Dayton, Ohio.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Loss Due to Cooling Internal-Combustion Engine

What is the loss in internal-combustion engines due to keeping the cylinder cooled to the working temperature, and is this loss the same with all kinds of fuel? E. W. M.

The loss to the cooling water will range from 25 to 35 per cent, although it is impossible to obtain an exact value, since the jacket absorbs part of the exhaust heat. The loss is greatest in a constant-pressure engine when the time of combustion is longer than with the explosive engine. Character of the fuel has little influence.

Use of Copper for Steam Piping

In modern land practice why is copper considered unsuitable as a material for steam piping? *M. C.*

Copper deteriorates rapidly under high temperatures and repeated stresses. At a temperature of 360 deg. F. its strength is about 15 per cent less than at ordinary atmospheric temperatures, and on this account, combined with the fact that the coefficient of expansion from heat is about 50 per cent more than that of iron or steel, copper pipe is unsuitable for the higher pressures of steam used in modern practice. Although formerly used for condenser and other low-pressure connections, on account of the adaptability of the material to construction of intricate forms, for present-day land practice these are made up of iron and steel, usually obtainable at less cost, with equal durability and greater safety.

Advantages of Suspended Boiler Setting

For a return-tubular boiler setting what is the advantage of suspending the boiler shell in place of having the boiler supported from side lugs resting on the walls of the setting? *M. W.*

The brickwork of a boiler setting should not make rigid contact with any part of the boiler, as difference of expansion between the boiler and masonry causes cracking of the brickwork and impairment of the strength of the walls, requiring frequent repairs. When the boiler is supported by side lugs or brackets resting on the walls of the setting, it is difficult to distribute the weight equally on the lugs and, until crushing or displacement of the masonry has taken place, the load is mainly supported at three points. With the suspended type of setting, the boiler is supported by hangers suspended from I-beams which rest on posts or piers that are independent of the side walls, and to insure distribution of the boiler load on the hanger pads, equalizers may be used between the hangers and main supporting beams.

The suspended type of setting may be made safer against damage to the boiler and connections from settling, the setting is more durable, and since the side walls are relieved of supporting the weight of the boiler, they can be designed, constructed, repaired or replaced regardless of that service.

Babbitting Boxes of Small Engine

We have found difficulty in babbitting the upper sides of one of the boxes of a small engine. How can the metal be made to fill the cavity? *R. J. A.*

Surface and interior cavities sometimes are caused by having runners and risers too small for the metal to remain liquid and feed the casting until it has set throughout. It may be that the box and mandrel were not sufficiently heated to prevent the metal from becoming so chilled that it could not meet from opposite sides of the mandrel. The "sprue" or runner, should be built up with clay several inches above the top of the box, so the molten metal may be supplied under greater head and there should be a vent or riser to prevent pocketing of air in the upper part of the cavities which are to be filled with babbitt. Best results will be obtained by thoroughly cleaning and tinning the box before babbitting and continuing the pouring until the flow of metal from the vents is stopped off and the riser is kept filled.

Action of Holding Coil on Starting

Why does the arm of the starting rheostat used with series motor return to the off position immediately the line switch is opened, when if a similar type of rheostat is used with a shunt motor, the arm goes back to off position only after the motor's speed is much reduced? *A. A. A. R.*

There is only one circuit through the series motor, which on the smaller-sized motors includes the holding coil on the starting box, the armature and field coils on the motor. As soon as the line switch is opened, the circuit through the holding coil is opened and it releases the arm, which comes to the off position. If the holding coil is connected across the line as for the larger-sized motors, the coil will also be connected across the motor terminals. However, when the switch is opened, even if the motor circuit may be closed through the holding coil, the machine cannot become a generator, since before a series motor can be changed into a generator its field connections must be interchanged. Even if it could become a generator, the current through the holding coil would be so small that the voltage of the circuit would immediately drop to near zero and the arm on the starting box be released by the coil and come to the off position.

With the shunt or the compound motor the shunt-

field winding is connected in parallel with the armature so that when the line switch is opened and the motor continues to run owing to its own momentum and that of the load, it becomes a generator and sets up a current through the holding coil. This current through the holding coil causes it to retain the arm on the starting box in the arm position until the motor has slowed down and the current in the holding coil is reduced due to the reduced voltage. This condition exists whether the holding coil is in series with the shunt field winding or connected across the line.

Submergence for Air Pipe

With an air-lift pump for raising water from a deep well, what is the best depth for putting down the air pipe? *P. B. A.*

No formula can be given for determining the best depth for putting down the air pipe, on account of the variation in combination of the conditions found in different cases, and more especially when there is uncertainty of the amount of drop of the ground-water level during the operation of pumping. Under favorable conditions, good results have been obtained with deep wells when the depths of submergence (or distance from the level of the ground water, when operating, down to the point where the compressed air is released) is about 60 per cent of the total air lift, measured from the foot of the air pipe up to the level of the point of discharge from the water pipe. The best submergence under any particular set of conditions should be determined by experimenting before details of an installation are made permanent.

Shortest Cutoff for Throttle-Governed Slide-Valve Engine

What is the shortest cutoff we can get with a throttle-governed slide-valve engine, and what changes have to be made in the valve setting? *P. H.*

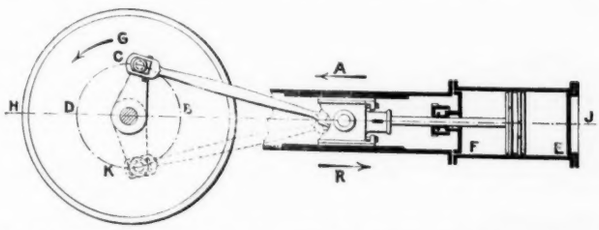
Under favorable proportions of inside and outside lap and valve travel the shortest cutoff practicable for a throttle-governed slide-valve engine is one-half to five-eighths of the stroke. Earlier cutoff results in port opening so slow and insufficient as to cause wiredrawing that will admit much less than the steam-chest pressure to the cylinder, even in the beginning of the stroke, and the excessive compression obtained is also objectionable for this type of engine. To obtain earlier cutoff with a given valve and eccentric, first lengthen or shorten the eccentric rod or the valve stem to obtain the same amount of valve travel each side of the admission edges of the steam ports for a complete revolution of the crankshaft or complete revolution of the eccentric around the shaft. Then from either dead-center position, place the crosshead at the fraction of stroke desired for cutting off and set the eccentric forward on the shaft to a point where the admission edge of the valve just closes the port of that end of the cylinder from which steam should be just cut off. For an ordinary D slide valve with outside admission which has the valve stem connected to receive its motion in the same direction as the eccentric rod, the eccentric should be more than 90 deg. and less than 180 deg. ahead of the crank. But where a rocker is used for driving the valve rod in a direction reverse of the direction of motion of the eccentric rod, or for the same direction with a valve having inside admission, the eccentric should be less than 90 deg. behind the crank. Where there is both a reversing rocker and valve with inside admission, the eccentric should be between 90 and 180 deg. ahead of the crank.

Direction of Running Motor-Driven Compressors

We operate two horizontal motor-driven compressors which are running over; that is, the connecting rod of each rises at the beginning of a stroke of the crosshead toward the crank. These machines have the bored guide construction with babbitted crosshead shoes and are in good alignment. Why is it that the top shoes and guides get hot and the bottom ones stay cool? I have always been informed that the pressure is on the bottom guide when running over and on the top guide when running under. *F. V. B.*

The top shoes run warmer because the crosshead pressure is against the upper guides, since in a motor-driven compressor the crank is the driver of the connecting rod and crosshead, and when the compressor "runs over," the rod tends to lift the crosshead and cause it to exert upward pressure.

The reason for downward pressure of the crosshead against the lower guide of an engine that runs over may be understood by reference to the figure. For a stroke of the crosshead when driven by the piston in the



Engine runs over with crosshead pressed downward. Motor-driven compressor runs over with crosshead pressed upward

direction of arrow *A*, the crosshead imparts a push to the connecting rod with movement of the crankpin through the semicircle *BCD* in the direction of arrow *G*. From beginning to end of the stroke of the piston from *E* to *F*, the crankpin is above the center line *HJ*; from the direction of the connecting rod the push exerted on the rod is upward and its reaction on the crosshead is downward. During the return stroke, movement of the crosshead in the direction of the arrow *R* exerts a pull on the connecting rod while the crankpin is drawn around the semicircle *DKB* below the center line *HJ*; the pull is upward and reaction of the crosshead is downward against the lower guide for any position of crank and connecting rod below the center line *HJ*, such as shown by the dotted lines.

However, when a motor-driven compressor "runs over," rotation of the crankshaft in the direction of the arrow *G* causes the crankpin to exert a pull on the rod when it is above the center line and a push when below the center line, either of which tends to lift the crosshead and create pressure against the upper guide, which is the reverse of the direction of pressure on the guides when an engine runs over. When the compressor is driven to "run under"—that is, reverse to the direction of arrow *G*—the direction of action of the connecting rod on the crosshead is downward, and as better conditions for lubrication and running are obtained with the pressure from the crosshead received on the lower guide, a motor-driven compressor should "run under."

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Storing Energy

THAT energy is nothing but the capacity for doing work and that it can exist in chemical, electrical, mechanical, thermal and other forms are facts with which all engineers are familiar in a general way. The limitations on the storage of energy in these various forms is an interesting subject for speculation, since the question of energy storage is of practical importance.

The most concentrated energy storage known is that inside the atom. It has been pretty well established that atoms are made up of electrons and resemble the solar system in some ways. The atom is supposed to consist of a small central nucleus corresponding to our sun with several electrons (particles of negative electricity) revolving around it as enormous speed. These correspond to the planets. Since the speeds of these electrons approach that of light, their kinetic energy (energy of movement) is enormous. Thus the real energy contained in a lump of ordinary dirt is beyond comprehension. This energy, is however, locked up. So far no one has been able to release it in *appreciable quantities*. It is conceivable that atomic energy may be a source of power in the future, but whether the release of the enormous atomic energies will be either practicable or desirable remains to be seen.

Hydrogen Heads the List

Leaving atomic energy out of consideration, by far the most concentrated form of energy with which we have to deal is the chemical energy of fuels. Hydrogen heads the list of all fuels on a weight basis with forty-eight million foot-pounds of energy per pound. That is, if a single pound of hydrogen gas were burned completely, and all the heat energy produced turned into work without loss, it would be sufficient to raise a ton weight 4½ miles straight up in the air.

Attention should here be called to the fact that only a fraction of heat energy can be turned into work, the rest remaining as heat. When fuels are burned, chemical energy becomes heat energy. A fraction of this may be turned into work, the rest remaining as heat.

Of all forms of energy heat is the most stable—the easiest form to get into and the hardest to get out of. It is fairly easy to turn chemical energy into heat, while work and electrical energy turn into heat of their own accord. One hundred per cent of the electrical energy delivered to the consumer changes to heat. That lost in the wiring becomes heat as does that going to heating appliances. The same is true of lamps, since they radiate nothing but heat, part of which (being visible to the eye) is called light. Motors turn part of the electrical energy into heat at once, but deliver most of it as work to the driven machine. The latter turns it all to heat eventually.

Electrical energy may be changed directly to work and *vice versa* very effectively, although a little of the energy slides away as heat in each transformation. The most difficult problem in engineering is that of turning heat energy into any of the other forms.

This rather long "aside" is introduced to emphasize the fact that only a fraction of the energy in a pound of hydrogen or other fuel ever could be turned into work.

With this reservation, it is interesting to note that the energy in a single pound of fuel oil is about fifteen million foot-pounds, while that in a pound of average coal is about ten million foot-pounds. The figure for coal is over ten times that for dynamite.

Next to chemical means the form in which the greatest amount of energy can be stored in a body practically is that of sensible or latent heat. Starting at 70 deg., it requires 110,000 ft.-lb. to raise the temperature of a pound of water to 212 deg., the boiling point under atmospheric pressure. To evaporate it requires an additional 750,000 ft.-lb., so that a single pound of steam at atmospheric pressure contains 860,000 ft.-lb. above room temperature. If this energy could all be turned into work, it would be sufficient to raise one ton 430 ft. vertically.

While steam has a much higher energy content per pound than water at the boiling temperature, water contains much more energy per cubic foot. For this reason water is practically a much better medium than steam for the storage of energy, since the cost of a container for a given pressure depends mainly on the volume.

To see how this works out, take the case of a tank of 1,000-cu.ft. capacity and compare the energy that can be stored in it in the form of hot water and in the form of steam. Take the pressure at 100 lb. gage and the room temperature at 70 deg. Each pound of water at the boiling point would contain (above room temperature) 210,000 ft.-lb. of energy, while each pound of steam would contain 895,000 ft.-lb. But the tank holds 56,000 lb. of water as against 258 lb. of steam, so that the total energy contained would be 11,800,000,000 ft.-lb. in the case of the water and 231,000,000 ft.-lb. for steam. The hot water would store fifty-one times as much energy as the steam.

Hot water has now come into practical use in power plants for the storage of energy. The apparatus used is called the "steam accumulator." It consists of a tank built to store large quantities of hot water under pressures ranging up to 100 lb. per sq.in. gage, with devices to facilitate the absorption of steam by the water when the pressure rises and its evolution when the pressure falls.

Over one hundred such accumulators have already been installed in Europe, and several are being erected in American plants. Their function is to act as "flywheels" to even up the inequalities between the supply of steam and the demand.

Suppose an accumulator works between the pressure limits of 100 lb. gage and 50 lb. During a period of low demand the excess steam produced goes to the accumulator, where it is absorbed by the water. The pressure gradually rises, and with it the temperature, the latter reaching 338 deg. F. when the pressure reaches 100 lb.

Increased demand for steam lowers the pressure, which results in boiling. So the temperature of the steam gradually falls with the pressure until it reaches 298 deg. at 50 lb. pressure. The fall of 40 deg. is sufficient to turn about 4.5 per cent of all the water into steam. For this range of pressure the energy storage per pound of water is about 52 B.t.u. or 40,000 ft.-lb., measured above room temperature.

Flywheel Stores Little Energy Compared with Water or Fuel

A flywheel is often pictured as a great storehouse of energy, but it makes a bad showing when compared with the forms of storage already mentioned. A pound of metal in the rim of a flywheel traveling at the rate of a mile a minute contains only 120 ft.-lb. of kinetic energy.

Arranging these forms of energy storage in order of the relative energy stored per pound, we have the following:

Kind of Storage	Relative Energy Stored per Pound of Substance
Flywheel traveling a mile a minute	1
Hot water (100 lb. gage to 50 lb.)	334
Dynamite	7,500
Coal	83,500
Oil	125,000
Hydrogen	400,000

On account of the relatively small amount of energy that can be stored in a flywheel, this method is used only for momentary fluctuations such as those that occur in a single revolution of a steam engine. The steam accumulator can practically handle fluctuations lasting from several minutes up to an hour or two. The energy stored in coal or oil is so great that a yard full of tanks or coal piles may contain enough energy to operate a plant for a month.

New and Improved Equipment

Power Feed for Cokal Stoker

Over two years ago a hopper feed, operated manually, was added to the Cokal hand stoker. As reported in the May 16, 1922, issue, this was an improvement over hand firing. Another improvement is the recent addition of a power feed. It is so designed that it may be applied to an installation in service without change and interconnected with the hand feed so that transfer from one to the other can be made quickly.

The new power feed consists of a driving shaft extending across and attached to the front of the stoker. Through an inclosed gear reduction and a chain it is driven by a small motor. The shaft is equipped with cams, one for each feeder block, which operate adjustable cam forks. From the cams movement is imparted to the cam forks, and these in turn, through interconnecting links, move the feeder blocks slowly forward and back to introduce the coal into the furnace from the stoker hopper. The cams are set at different angles on the shaft so that only one feeder block is pushing coal into the furnace at any one time. In this way the power requirement is so reduced that a ¼-hp. motor is large enough to operate two stokers. A factor in the small power requirement is the equipment of the cams with rollers to reduce the friction.

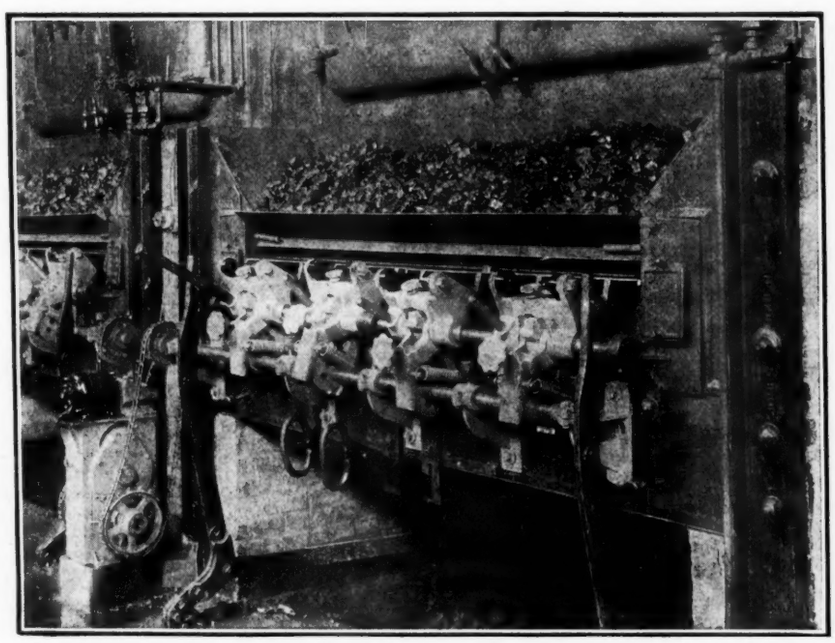
Such an installation is shown in the accompanying photograph, taken at the plant of the Angel Guardian Orphanage in Chicago, where four hopper-feed stokers were re-equipped for power feed.

Adjustment of the rate of feed is effected by expanding or contracting the cam forks by means of the handwheel shown at the front of each unit. Expanding the forks reduces the travel of the feeder block, and contracting the forks increases the travel, thus decreasing or increasing the coal feed as may be desired. Where the plant has damper regulation, an automatic mercury cutoff switch is provided to stop and start the motor in accordance with the damper position. The small handwheel and the toothed sector at the top of the unit provide for setting the feeder block at the desired openings for different sizes of fuel.

To guard against breakage owing to obstructions that may get into the hopper, spiral springs in tension allow the cam forks to expand rather than continue to impart motion to a feeder block that has been obstructed. As soon as the cam has completed its 360 deg. of travel and on the next revolution starts the return travel of the feeder block, the obstruction is freed automatically and operation is resumed as before.

To change from power to hand-feed in case of failure of the service or to pick up quickly to meet a sudden load demand, the feeder block can be released from the power feed by loosening the small handwheel at the top of each unit. To resume the power feed, the handwheels are tightened.

In the installation previously referred to, it is claimed that the adoption of power drive made approximately 15 per cent reduction in coal consumption.

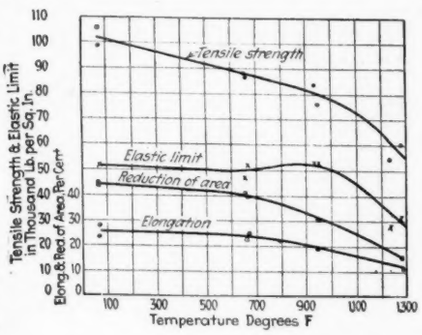


Method of attaching power drive to hand stokers

Everbrite Metal

A metal, known as Everbrite, somewhat similar to "monel" is now being produced by the Curtis Bay Copper & Iron Works, Baltimore, Md.

The metal is a homogeneous forged copper-nickel alloy having high physical characteristics at high temperatures as



Shows characteristics of metal at high temperature

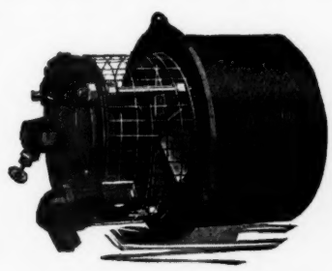
shown by the accompanying chart. It is claimed by the manufacturer to be non-corrosive and practically acid-resisting to all common acids.

This metal is now being forged into valves bodies from ¼ to 2 in. diameter. It is also expected that it will be possible to draw this metal into tubes.

Buffalo Forge Undergrate Blower for Small Plants

The Buffalo Forge Co., Buffalo, N. Y., has recently added to its general line of exhausters and blowers a small undergrate blower for use in the small power plants to supply forced draft.

The blower consists essentially of a six-blade propeller wheel of aluminum



Steam-driven blower unit

composition, a cast-iron housing and a small steam turbine which furnishes the motive power. The propeller wheel is 16 in. in diameter and may be operated at any speed up to 4,000 r.p.m. The blades of the turbine are made of monel metal and the shaft is carried in ball bearings placed between the fan blade and the turbine wheel. The size and number of nozzles furnished de-

pends on the maximum speed at which the unit is to operate and the steam pressure available. The blower may be used in connection with a pressure-regulating valve by means of which the volume of air delivered to the ashpit will vary inversely as the steam pressure. The valve can also be set to stop the blower automatically when a certain pressure is reached and then restart as the pressure drops. The unit will develop a maximum of 5,000 cu.ft. of air per minute at 4,000 r.p.m.

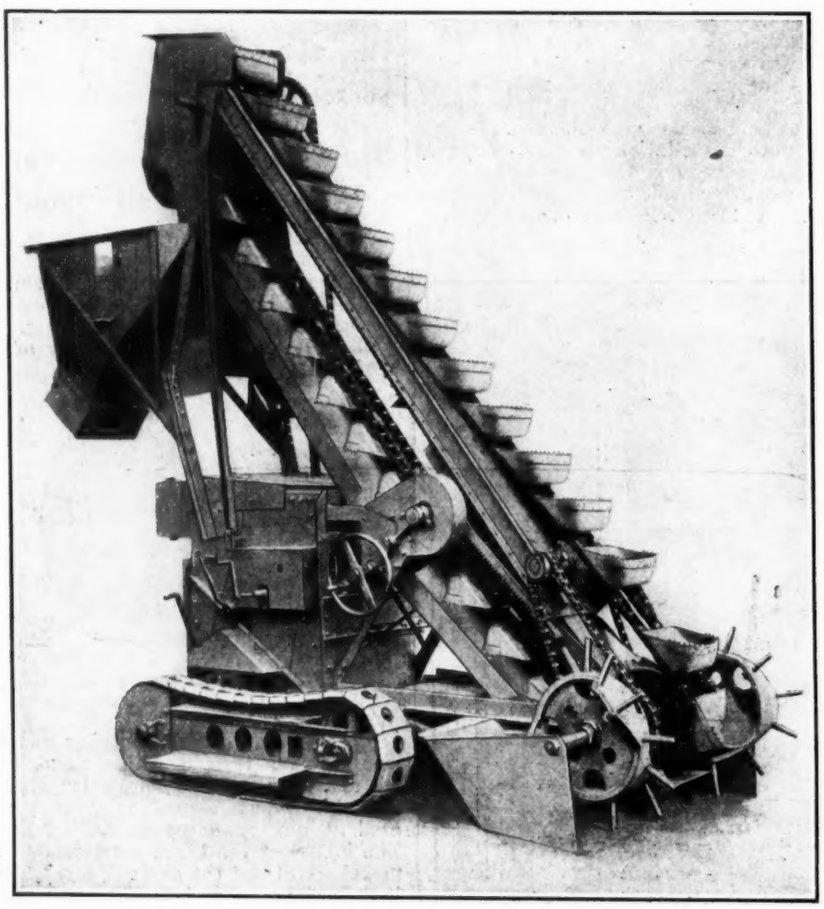
Jeffrey "Tanktred" Portable Loader

A recent improvement to the line of portable bucket-type loaders manufactured by the Jeffrey Manufacturing Co., Columbus, Ohio, is the addition of the "Tanktred" crawler mounting and an improved type of clean-up device on the lower end of the boom, as shown in the illustration. Other parts of the apparatus follow along lines similar to the radial loader built for some years by this company.

The loader has a capacity of 1½ to 2 cu.yd. per min. and is designed to handle rough material such as crushed stone in sizes up to 3½-in. ring and coal up to 8-in. lump.

The clean-up device fitted to the lower end of the loader boom consists of revolving spiders having hardened steel pin inserts which serve to loosen compact material and carry it forward into the path of the buckets. The spiders are driven independently by two chain drives from a countershaft on the boom.

The entire driving unit is inclosed in a steel-plate housing, the operation of the machine being controlled by levers conveniently located on the outside. Propelling, steering and operation of the elevator are accomplished through multiple-disk clutches. The treads are controlled by brake mechanism on the differential shaft, making it possible to turn the machine on the center of either crawler as a pivot. Two speeds are provided both forward and reverse, the fast speed 50 ft. per min. for moving from place to place and the slow speed about 2 ft. per min. for feeding into the material.



Portable loader equipped with "Tanktred" crawler mounting

Bethlehem-Weir Corrosion Detector

As a means of readily examining the feed water at any point of the feed system with regard to its corrosive properties, the corrosion detector shown in Fig. 1 was developed by the G. & J. Weir Co., Glasgow, Scotland. This detector has been extensively used in Great Britain and Europe and is now being introduced in this country by the Bethlehem Shipbuilding Corp., Bethlehem, Pa.

The construction of the detector will be readily understood by referring to the section, Fig. 1. The feed water to be examined is passed over one side of a polished steel disk or plate that is heated on the other side by a current of steam. If the water contains corrosive gases in solution, these gases

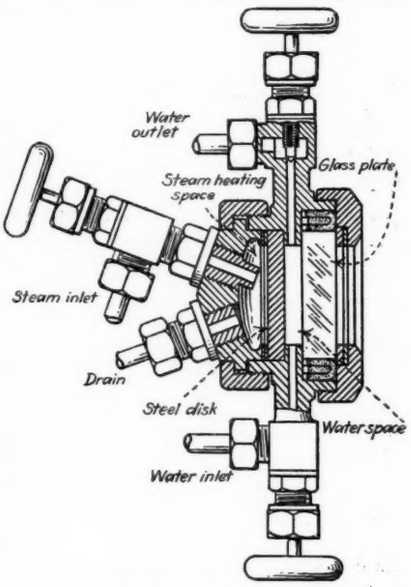


Fig. 1—Highly polished steel disk is subjected to action of feed water, corrosion observed through glass window

are released in active condition chemically and attack the polished surface of the steel disk. Contrary to the general opinion held by engineers that corrosion is a comparatively slow process, the action of gases on the steel disk takes place almost immediately. The instrument is provided with a glass window so that the action of the water on the disk may be observed. If the water is non-corrosive, the disk retains its original polished appearance.

In power installations it is recommended that a standard regulation be laid down for periodical tests—usually

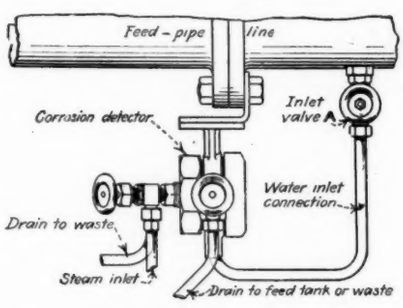


Fig. 2—Method of connecting detector to feed-pipe line

once a month in systems reasonably free from corrosion. The duration of exposure of the disk is made the same at each test, so that by comparing the series of disks obtained, it can be seen whether improvement or the reverse is taking place, a sufficient time to permit of adequate discoloration for purposes of comparison being allowed.

Fig. 2 shows the general arrangement of connecting the detector to the feed-pipe line.

Iron and Steel Electrical Engineers Hold Nineteenth Annual Convention

WITH a total registration of over 1,000, the nineteenth annual convention of the Association of Iron and Steel Electrical Engineers proved to be the most successful in the history of the Association. This year's meeting, which was held in Duquesne Gardens, Pittsburgh, Pa., during the 5 days Sept. 15-19, not only celebrated the nineteenth birthday of the Association, but also commemorated the thirtieth anniversary of the adoption of electric motors for use in the manufacture of iron and steel. It was therefore fitting that Pittsburgh, the greatest steel center in the world, should be chosen for this year's convention.

The iron and steel exhibition, which was held by the Association in conjunction with last year's convention and proved a success, was equaled at this year's, if not surpassed. This exhibition also was held in Duquesne Gardens, with 120 companies exhibiting equipment used in the manufacture of iron and steel.

Among the entertainment features were a ball held in the William Penn Hotel on Monday evening and the banquet at the same hotel on Thursday evening, attended by more than seven hundred.

This year's convention had only four technical sessions and one general business meeting. These were held during the morning of each day, thus leaving the afternoon and evening open for the members to attend the exhibition. This has been tried this year as an experiment, as it was felt by those responsible for the Association's activities that, with two technical sessions a day as in previous years, insufficient time was available for members to attend the exhibition and other points of engineering interest.

On Monday morning the convention opened with a general business session, at which the various committee reports were presented. Contrary to the custom of previous years the Electrical Development Committee's report was not presented at this year's meetings, but will appear in the December issue of the *Iron and Steel Engineer*.

Of the other committee reports that of the most general interest was the report on ball-bearing standardization. During the last year a number of association section meetings were held at which the problem of the application of ball bearings to steel-mill motors was discussed. These meetings, in conjunction with the activities of the committee, have practically brought this work to the point where a set of standards may be adopted for motors up to 100 hp. capacity. The matter is now in the hands of the Electric Power Club awaiting final action. The series of ball and roller bearings that it is proposed to adopt as standard is that known as No. 300. This gives standard dimensions for inside and outside diameters of the bearings of all makes up to those used on 100-hp. motors.

The papers on fuels and combustion, which formed a prominent part of the previous years' proceedings, were absent this year. This part of the Association's work has become of such importance that it was decided to hold a fuel-saving conference. Last April the first of these conferences was held in Pittsburgh, when two days were devoted to a discussion of various phases of the fuel and combustion problems in the iron and steel industry. The success of this conference was such that it has been decided to make the fuel-saving conference an annual part of the Association's activities, such conference to be held in the early spring.

Combustion Control

One of the papers of particular interest to *Power* readers was "Combustion Control," by E. G. Bailey. In presenting his paper, Mr. Bailey called attention to the many factors that must be considered in properly applying automatic combustion control to boilers and described two installations that his company had made, one of these being in the Brunot's Island plant of the Duquesne Light Co. at Pittsburgh and the other in the plant of the Cleveland Illuminating Co. Both of these are on powdered-coal installations. An abstract of this paper will appear in an early issue.

During the discussion it was pointed out that no matter how good the combustion-control system might be, the results depended to a considerable extent upon the operator. Many of the difficulties in earlier attempts to control combustion automatically were laid to the faults of the stoker feed. In a number of the stokers of recent design these difficulties have been overcome and stokers could be obtained that would maintain a uniform feed and draft over long periods.

It was the consensus of opinion that combustion control was not a cure-all for the combustion evils in boiler operation. In fact, automatic control is not justified in all existing plants, since in some cases the more leeway the fireman is given in the control of the boiler the better off he is.

As an example of how little the unit feeder affected operation, attention was called to one pulverized-coal installation where eight of the sixteen burners were shut off without seriously affecting operation. As to efficiencies for modern installations it was said that at the Cleveland Illuminating Company's plant 90 per cent was obtained on the new boilers in regular operation, and on acceptance tests as high as 92 had been reached.

Electric Heating Power Loads

By the use of a chart E. D. Sibley, in a paper "Electric Heating with Special Reference to Central Stations," showed the relative costs of four common sources of heat—coal, gas, fuel oil and electricity—in terms of dollars per 100,000 B.t.u. used in furnaces and baking ovens. One of the reasons that electricity has been able to compete with fuel for heating is its high efficiency of application which cannot be effected by the operator. A 50 per cent excess air in burning city gas will double the cost for producing a given amount of heat, and with fuel oil 50 per cent excess air will, according to Mr. Sibley, increase the cost about four times.

Attention is called to the surveys and estimates made by the Industrial-Heating Committee, of one of the large manufacturing companies, which indicates that in this country today there is a connected industrial-heating load of approximately 1,250,000 kw. Of this 1,000,000 kw. is connected to central-station lines with an annual power consumption of over 2,000,000,000 kw.-hr. and producing an annual revenue of $40,000,000. Of this total heating load about 25 per cent is melting furnaces, which account for about 37 per cent of the power consumption and 28 per cent of the revenue.

Crane-Hoist Travel Limit Devices

With the purpose in view of getting the Association to approve general standards governing the construction, installation and maintenance of crane-hoist limiting devices in order to prevent accidents, a paper was presented by Walter Greenwood, safety engineer with the Carnegie Steel Co.

The failure of hoist limiting devices is of comparatively frequent occurrence, and in many instances greater safety has been secured by removing these from service, so that the entire responsibility is thrown on the crane operator. There are no available data regarding accidents that have occurred under these circumstances, but when the proper type of operator is available, this method has proved satisfactory.

It must be recognized that failures of limiting switches to prevent the overtravel of crane hoists with consequent breaking of cables, dropping of load, possible injuries, etc., are ordinarily to be expected. No matter how perfect the limiting device is, there will come a time when it fails, due to wear if neglected. Although this can be prevented by proper maintenance, it is difficult to guarantee such attention.

In discussing hoist limiting devices, a number of points were brought out. The limiting switch should be considered only as an auxiliary to manual control. The principal features are the interruption of current and the application of dynamic braking. It may be of the type that automatically resets so that no inconvenience falls upon the operator. In such cases he may rely on the limit switch instead of manual control, for stopping the hoist. If it does not automatically reset, the inconvenience to the crane man of putting it in operation may serve to deter him from running the hoist to the limit. On the other hand, this may afford an incentive for the operator to put it out of service deliberately so as not to be bothered with manual resetting.

Proper attention should be given to the method of installation and maintenance so reliability will not be reduced. What appears to be a good way to prevent operators from making the hoist limit a convenience, is to provide a telltale device that will reveal when and by whom the switch has been brought into service. The operator will seldom knowingly stop by the limit switch when he knows a penalty is involved.

Frequently, the instructions of the maker of a hoist limit switch are disregarded. This is added proof that general principles governing the design, installation and maintenance should be standardized.

Interconnection Between Steel-Mill Power Plants and Central Stations

The Friday morning technical session was devoted to discussing the power problems of the steel mills and how the central stations can assist in solving these problems. The first paper presented was "The Steel Industry and the Electric Utilities," by Merrill Skinner and F. D. Mahoney, who said that "considering the difference in the load characteristics of the blast furnace and rolling departments and the difficulty of properly balancing these two elements of steel-mill power systems, it has heretofore been impossible to utilize completely the waste heat available. From an economic point of view it seems logical that some way will be found to interconnect the steel-mill power systems with some reservoir that can absorb their output over periods when the available power is not required for mill purposes. The large electric utility systems offer a splendid opportunity for so doing, and the sooner these facts are faced the sooner will these two basic industries get together to their mutual advantage. When the obvious advantages to the steel industry of such interconnections are considered, it is suprising to note how little progress has been made toward this end.

The advantages of interconnection to the steel industry are enumerated as follows: Reduction of investment in stand-by generating and transmission systems; elimination of waste-heat losses; additional coal-burning boilers solely for producing power should be unnecessary; more complete utilization of waste heat and the application of power for driving rolls by means of electric motors will reduce the cost of making iron and steel and prevent duplication of investment by the steel companies and central stations in generating and transmission equipment.

Advantages to the central stations were summarized as: Make possible the reduction of the margin between the load carried by the central station and the prime-mover capacity, which would also apply to transmission lines; energy generated from byproduct heat represents an additional source of low-cost energy for the central station; assist in right-of-way problems; and possibilities of increased sales of energy to the steel mills.

Difficulties to be overcome are: The prejudice that exists to some extent among steel-mill engineers against central-station service; comparison between the cost of delivering electric service from the steel-mill plant and from the electric utility; the difference in frequencies employed by steel mills and neighboring central stations; and development of an equitable basis for metering and billing.

The conclusion is drawn that the problem of interconnection, huge and difficult as it may seem at first glance, can be solved to the mutual advantage of the interested parties. Interconnection, in order to utilize the waste heat of the iron and steel industry, is economically sound and of paramount importance. Interconnection, in order to conserve investment in plants and lines of both parties, is equally in line with progressive thought. In the light of recent developments in superpower systems the objection to parallel operation and distrust of central-station service seem more fancied than real. It is hoped that the next few years will witness some long strides forward toward this goal.

Power in the Iron and Steel Industry

The second paper presented at the Friday morning session was by Banton R. Shover, on "Power in the Iron and Steel Industry." It was pointed out that while reciprocating engines still comprise the larger proportion of power units, the turbine is coming more and more into use. In 1909 the turbine was not considered of enough importance to be listed separately in the census report, but the 1919 report gives 955 units, aggregating 893,884 hp., or 21 per cent of the total steam power listed. Two manufacturers of turbo-generators report records of 334 units of their make, ranging in size from 300 to 17,000 kw. and totaling 908,425 kw., as being in use in the iron and steel industry at the end of 1923. Of these units 66, totaling 357,375 kw., or 39 per cent, have been installed since 1918.

Although the United States Bureau of Census figures show 161 per cent increase in the installed capacity of gas engines in steel mills from 1909 to 1919, attention is called to the fact that this does not indicate a radical tendency in this direction, since the major portion of the total capacity of gas engines used in steel mills was installed during the period from 1905 to 1914.

Increase in speed, capacity and efficiency of the turbine, together with its lessening cost per horse power, in the opinion of Mr. Shover, have swung the tendency toward it, and close inquiry shows the installation of only five gas-engine generating units aggregating 21,140 kw. capacity with no blowing units since 1918. This capacity, compared with the 357,375 kw. turbo-generators previously mentioned as having been installed during the same period, clearly shows which method of power generation is at present preferred. The advantage that the internal-combustion engine has in regard to heat efficiency will probably bring it into favor again when fuel has advanced a certain amount in cost (apparently to about $10 per ton) particularly if the installation cost can be reduced and reliability increased, but until they occur the gas engine is not likely to be restored to favor in America.

Mr. Shover estimates that in 1922 the coal equivalent of 4,000,000 long tons should have furnished all the power required for making the United States production of coke, pig iron and ingots and roll the ingots into finished product. To produce this power 12,282,850 tons of coal and waste heat to the equivalent of 8,188,567 tons of coal were used, or a total of five times the estimated requirements, which offers a fertile field for the development of future economies. A large loss of waste heat available for power purposes results from the demands for power in the mills not synchronizing with the supply of waste heat. It is pointed out that this conditions can be met by an interchange of electric power with the local public-service company.

The first use of the electric motor in the steel industry in America reported to the Association of Iron and Steel Electrical Engineers was the installation of three small units in 1891. Three electric manufacturing companies recently report having furnished a total of 914 motors of over 300 hp. capacity and aggregating 954,410 hp. for driving non-reversing hot mills in steel works. To date the three larger manufacturing companies have furnished a total of 50 reversing drives totaling 201,800 hp., and there are in addition a few such motors supplied by other makers. While the number and capacity of reversing steam engines in use surpasses those figures for motors, the tendency is shown by the fact that since 1918 there has been a total of 19 reversing motors installed as compared with only two reversing steam-engine drives.

From the data, estimates and general history of the art Mr. Shover draws the following deductions as the present and probable future tendency of power generation and application in the iron-and-steel industry:

1. Electrification of all power-driven apparatus except blast-furnace blowers.
2. Substitution of turbo-blowers, or possible gas engines, for reciprocating steam blowing engines.
3. Purchase of power requirements by plants that have no waste heat requirements.
4. Complete economical utilization of waste heat by means of turbo-generators for electric-power generation, except where this heat can be used to better advantage for "process" or has a market value greater than its coal equivalent.
5. Interchange of electric power between plants generating power from waste heat and public-service companies.

Officers Elected for Coming Year

The following officers were elected for the ensuing year: President, A. C. Cummins, Elec. Supt., Carnegie Steel Co., Duquesne, Pa.; first vice-president, George H. Schaeffer, Elec. Engr., Carpenter Steel Co., Reading, Pa.; second vice-president, S. S. Wales, Elec. Engr., Carnegie Steel Co., Pittsburgh, Pa.; treasurer (re-elected), James Farrington, Elec. Supt., Wheeling Steel Corp., Steubenville, Ohio; secretary, F. W. Cramer, Asst. Elec. Engr., Bethlehem Steel Co., Johnstown, Pa.

Smoke Abatement Bill in British Parliament

The British Parliament is considering a "Smoke Abatement Bill." An important amendment to the original Bill is that the offender must be notified within 24 hours of any alleged nuisance he has made through smoke emission. This early notification is expected to draw the attention of the owner or operator to the emission of offensive smoke and to give him the opportunity of remedying the trouble first instead of presenting him with a summons long after the offense is committed. Often smoke is unintentionally caused. This method has proved more effective in Sheffield than the old penal method.

Power Machinery Exported Recently

According to figures given out by the Bureau of Foreign and Domestic Commerce, there was exported from the United States for the months of April, May, June and July (1924): 168 stationary steam engines, except turbines, at $176,128 and boilers of 287,867 sq.ft. of heating surface at $582,618; 805 Diesel and semi-Diesel engines at $329,-158; 1,199 stationary internal-combustion engines, over 8 hp., at $691,901; 64 waterwheels and turbines under 300 hp. at $25,402. Figures on waterwheels and turbines over 300 hp. are not available for June and July, but during April and May four were sold for $50,605.

Our neighbors in Canada, Mexico, South America and the West Indies were the best customers although Rumania, Latvia, Spain and the Philippines were good buyers.

Data Obtained on Fuel for Low-Pressure Plants

Accurate data on the effectiveness of combustion of bituminous coal and coke for generating steam under hand-fired low-pressure cast-iron boilers of a type actually used in heating large buildings have been obtained as the results of a study conducted by engineers at the Pittsburgh station of the Bureau of Mines. The experimental work has been under way since early in 1922. The effectiveness of different methods of firing the different coals tested was determined, as well as the relative value of the different fuels used. The results showed that the bituminous coals from the Pittsburgh and Lower Kittaning beds, Pennsylvania, and the coke were of about equal steaming value at the lower pressures but at medium and higher pressures permissible with this equipment, the coke had about 90 per cent of the steaming value of the bituminous coal.

Colorado Springs To Build Steam Plant

The City of Colorado Springs, having voted to own and operate its own electrical power plant, using hydro-turbines for the main plant, will erect as an auxiliary, a $500,000 steam plant, it is said. The steam plant will be near the city, along Fountain Creek and close to the Denver & Rio Grande Western railroad tracks. Wood & Weber are the electrical engineers in charge of the work.

Franklin Institute Hears Famous Men

The Franklin Institute began its celebration on Sept. 17, with scientists from all over the world in attendance. The official opening began with a luncheon to the delegates and guests at the Bellevue-Stratford. Following the luncheon a number of sectional meetings were held, which developed formal and informal discussion of an interesting nature.

"Photo-elasticity" was the subject covered by E. G. Coker, dean of the Engineering Faculty of the University of London, whose researches in the study of stress in structures and machines has aroused much interest. He brought with him an elaborate set of models to illustrate his application of some old engineering fundamentals in a new way which is said to be a mechanical achievement. Of chief interest in his talk was his explanation of the use of polarized light to detect weak points in machinery. This invention is being used at present by some industrial concerns in the United States and by the United States government.

Prof. John Sealey Edward Townsend, of Oxford, another British guest, spoke on "The Motion of Electrons in Gases." He said, according to press reports, that "the progress of scientific research in this country, owes a great deal to industrialism, chiefly through the independent studies of the great manufacturing companies, conducted in their own laboratories by their own workers. At the present rate of speed America will soon challenge the scientific supremacy of Europe, unless we over there are careful."

In the British delegation, besides the two mentioned, were Sir Ernest Rutherford, of Trinity College, who spoke on "The Natural and Artificial Disintegration of Elements," and Sir Charles Algernon Parsons, Newcastle-on-Tyne, the inventor of the steam turbine, who spoke on "Steel Turbines on Land and Sea." Prof. A. A. Michelson, a co-worker of Einstein, gave a talk on "Results of a Preliminary Determination of the Velocity of Light."

Gauley and Meadow Rivers Project Planned

The Gauley Power Co., a Charleston, West Virginia, concern, has filed a petition for a preliminary permit from the Federal government to construct a series of power dams in Gauley and Meadow Rivers, about fifty miles from Charleston. The application was made on Sept. 15 and a hearing on the subject is expected to be held on Oct. 1.

Arthur B. Koontz, secretary and treasurer of the company, said that the company was organized in 1912 and that J. S. Gallery, of Pittsburgh, was one of its backers. The improvement contemplated would cost in the neighborhood of $10,000,000, approximately $100,000 having already been spent on preliminary work in the river. It is expected that the company will also construct transmission lines to carry power to industries in Charleston and vicinity, according to press reports.

Colorado River Development Subject of Davis' Speech

The recent Denver speech of John W. Davis, candidate of the Democratic Party for president, dealt in part with the Colorado River problem. He said:

"While the development of our country and the progress of our people are best served through encouragement of individual initiative, there are certain activities which by reason of their peculiar national character can be more satisfactorily and expeditiously carried out by the national government. The improvement and development of the great Colorado River, which flows through your own state, illustrates the policy I have in mind. That river is an international as well as an interstate stream. It possesses the latent power to enrich all of the Intermountain States through which it flows. It may be used to irrigate millions of acres of the richest soil and can develop a tremendous horsepower that will reduce the cost of production upon our farms and any other industry within its broad basin.

"Yet, great as may be its potentiality for hydro-electric power, it has its limits, and these limits will be unfortunately reduced unless the development is carried out in such a way that the maximum benefit for all will be obtained. I do not favor the operation of power plants and the distribution of electricity by the government. This may well be done by private enterprise after the necessary dams have been constructed. But it seems to me that in this case the government should determine the location of these dams and the character of their construction and that such construction should be actually carried out by it."

Canadian Exhibition To Have New Electrical Building

The Canadian National Exhibition held yearly at Toronto, Ont., had this year its usual extensive exhibition of the latest achievements and developments in machinery. The exhibition authorities announced recently that the electrical building which has been under consideration for several years would be constructed for the 1925 exhibition. Work on the new building will be started at once, it is stated.

New Boilers for Lincoln St. Plant, Portland

Two additional boilers of 10,000 sq.ft. heating surface are to be installed in the new building which is being erected at the Lincoln Street steam plant by the Northwestern Electric Co. in Portland, Ore. This addition will provide enough energy to operate to full capacity the two 10,000-kw. turbo-generator units in the plant and furnish enough steam to heat the entire downtown district of Portland, where the company's steam-heating business is concentrated. The new boiler installation is expected to be completed for operation by Oct. 1.

Coal Will Remain Principal Source of Power, Says Smith

Dr. George Otis Smith, Director of the United States Geological Survey, writing about the World Power Conference for *Coal Review*, says:

"Many of us, when the word 'power' is spoken, think only, or at least first of water power. At the sessions of the World Power Conference in London, however, it was made plain enough that coal far outranks water as a source of power. Statistics there cited for six leading countries of the world showed that the coal produced represented five times the energy output of the water power utilized, and we know that even in the United States, with its great development of water power — about three times that of any other country— steam and internal-combustion engines, not including those of locomotives or automobiles, produce more than three times as much power as our waterwheels. This is the day of electricity, but by far the most of our electric energy is derived from coal.

"At the London conference emphasis was repeatedly placed on the dependence upon fuel for power and hence on the importance of moves for the coordination of our fuel supplies and for the better utilization of coal.

"A power program that works out any large gains in fuel economy is a program that you can afford to indorse. In support of my optimism I expressed my opinion that the waterfall is not a rival to the coal mine but its partner.

"Even America's generous share of potential water-power resources if fully developed could not meet the present demand for power. Nor has fuel oil displaced coal in the public utility plants, except perhaps locally and temporarily, the increase in their annual consumption of oil being only about three and a half million barrels as against nearly four million tons of coal.

"The most significant thing revealed by the comparison of power statistics collected by the Geological Survey is the increased efficiency in the use of coal. Last year the average generating plant turned out a kilowatt-hour with 2.4 pounds of coal, whereas in 1919 the average consumption was 3.2 pounds."

Power-Plant Refractories Survey Arranged

A co-operative agreement has been made between the Bureau of Mines and C. A. Hirshfield, of Detroit, representing a group of large central power-plant operators, to make a survey of present conditions relating to the use of power plant refractories. The survey will be conducted by engineers of the Bureau of Mines.

With the present high ratings at which boiler plants are being operated and the increasing use of pulverized coal with its attending high temperatures, the refractories now available for lining boiler furnaces are proving inadequate. In this survey a study is being made of the characteristics of refractories now available for use in power-plant boiler furnaces and the conditions under which they are used, their life in operating practice under the conditions prevailing at different plants and the way in which the refractories now marketed fail to meet these conditions. The purpose of the survey is to obtain fundamental data to be used in bettering refractory service.

Witbank Power Station in Transvaal To Be Large

In consequence of an agreement with the Electric Supply Commission, an electric power station is to be built at Witbank in the Eastern Transvaal. The station is to be constructed by the Victoria Falls & Transvaal Power Co. and will supply electricity to mines lying between the Rose and Glen Deep on the east and to the Crown Mines on the west.

With the exception of the mines supplied by the East Rand, Randfontein and the Kleinfontein power station, the mining groups on the Rand will take their supply of electrical energy from the power company during the life of the various mines or for about twenty years. The new station is designed to accommodate five 20,000-kw. turbo-generating sets. It is believed that the cost of generation at the station will be the lowest of any station in the world, as the plant is to be constructed to burn cheap slack. Large quantities of this class of fuel are available at Witbank, according to *The Engineer*.

Government Needs Inspectors and Examiners

The United States Civil Service Commission announces that following open competitive examinations: Local and Assistant Inspector of Boilers (steamboat); Junior Patent Examiner. The examination for these positions will be held on Oct. 22 and 23. The entrance salaries for the Steamboat Inspection Service will range from $2,100 to $2,950 a year. The entrance salary for Junior Patent Examiner will be $1,860 a year with advancement in pay being made up to $2,400 a year.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of United States civil service examiners at the post offices or custom houses in any city.

Steam and Water Power in Norwegian Industry

The total motive power employed by Norwegian industry at present aggregates approximately 1,800,000 hp., according to statistical information made available by the National Health Insurance Board of Norway. About 175,000 hp. is supplied by steam, the remainder being electrical power of which 1,600,000 hp. is supplied by the Norwegian waterfalls.

The growth in the use of power in Norwegian industry during the past decade and the rapid increase in the use of the nation's water-power resources are illustrated by the following table:

MOTIVE POWER USED FOR INDUSTRIAL PURPOSES IN NORWAY

Year	Total Horsepower	Water Power Supplied by Falls Horsepower	Steam Horsepower
1911	573,854	465,087	102,784
1912	777,087	662,905	106,738
1913	890,307	763,060	117,793
1914	948,976	807,557	131,116
1915	1,215,563	1,064,581	138,549
1916	1,274,682	1,121,335	110,188
1917	1,206,773	1,070,097	115,255
1918	1,292,001	1,126,807	149,742
1919	1,737,934	1,563,688	159,447
1920	1,803,690	1,603,567	176,491

West Virginia To Have 84,000 Hp. Plant

Recent press reports state that an application has been made to the West Virginia Public Service Commission by the West Virginia Power Co. for a permit to construct a large power dam in Summers County. The proposed dam would be situated approximately five miles south of Hinton, 2½ miles from the mouth of the Blue Stone River.

The West Virginia Power Co. is a subsidiary of the Virginian Power Co. The horsepower of the project would total more than 84,000, according to engineers' estimates. The dam, according to petition, would be of concrete and would be of the overflow type.

The application says that the Federal Government has granted a preliminary permit for construction. The applicant has signified that the State shall have power to regulate and control distribution of the power. It is also proposed to build a power plant and a 44,000-volt transmission line of 22 miles to Beckley.

Pennsylvania has 70 hydro-electric plants developing approximately 227,000 hp. George S. Beal, engineer for the water and power resources board, declared in an article on "Development of Water Power Projects in Pennsylvania," made public by the Department of Forests and Waters. He said a canvass 17 years ago revealed 1,260 water-power plants in the state then.

Denver Hopes to Get Smoke Ordinance

The Denver Chamber of Commerce, in co-operation with the City of Denver have appointed a smoke commission. The smoke nuisance has been constantly growing worse, and it is hoped that ways and means can be devised by the commission to combat it. Frank E. Shepard, superintendent of the Denver Mint and a mechanical engineer, is chairman of the Chamber's standing committee.

Brooklyn Polytechnic Starts Metals Inspection Course

The Polytechnic Institute of Brooklyn, N. Y., has recently announced the starting of a new special course, "Inspection of Engineering Metals." The course will be given by E. P. Polushkin in the evening school department, 99 Livingston St.

The course reviews briefly the fundamental principles of metallurgy of iron, steel and the most common copper alloys, the heat and mechanical treatment of metals and the common methods of testing materials. It gives a brief survey of the microscopic defects and deals with the features of inspection of the most common metals.

American Holding Company for Alabama Power Co.

The directors of the Alabama Power Co. have drawn up a plan, to be voted upon by the stockholders, at a meeting in Montreal on Oct. 10, whereby the control of the Alabama Power Co. and other properties will pass from the Alabama Traction, Light & Power Co., a Canadian corporation, to an American holding company, the Southeastern Power & Light Co., recenly incorporated in Maine. To put the new arrangement into effect, the newly created Southeastern Power & Light Co., which has an authorized capital of 100,000 shares of preferred stock and 500,000 shares of common stock, both without par value, will purchase all the properties and assets of the Alabama Traction, Light & Power Co.

Fuel Oil Courses for N. Y. University

The New York University, New York City, will start a course, on the domestic and commercial consumption of oil as a fuel and the competition which coal is giving to fuel oil, this fall, according to press reports. The course will be in charge of Dr. Ernest R. Lilley and will be open only to executives in the oil industry.

Dr. Lilley, in his announcement, pointed out that the increased uses of oil have arisen out of the tremendous surplus on the market of cheap crude oil, which, he says, forced upon oil men the necessity of providing ways of disposing of the excess product.

In addition to the discussion of oil consumption, phases of oil marketing such as legal transportation and storage, foreign tariffs and rules, competition, and the oil-burner developments will be studied.

Power from Tide on Marshes Will Be Used in Essex

Along with the steps taken for a barrage scheme for harnessing the tides for power generation on the Severn, comes the plan put forward by Leonard Weaver, whereby the flow of the tides over the marshlands at West Mersea in Essex, England, may be utilized to provide power for Colchester and Southend.

The scheme, briefly outlined, will take advantage of the miles of sea wall which is already in existence and which protects the marshes. Mr. Weaver proposes to make sluices in the wall through which the water will flow, driving turbines and passing into a dammed-up creek which will serve as a reservoir. When the tide ebbs, the water will flow out of this reservoir and keep the drive of the turbine going. He figures on producing electricity at a cost of about one-eighth of a penny a unit, in place of two pence, which is the average cost to produce it by steam.

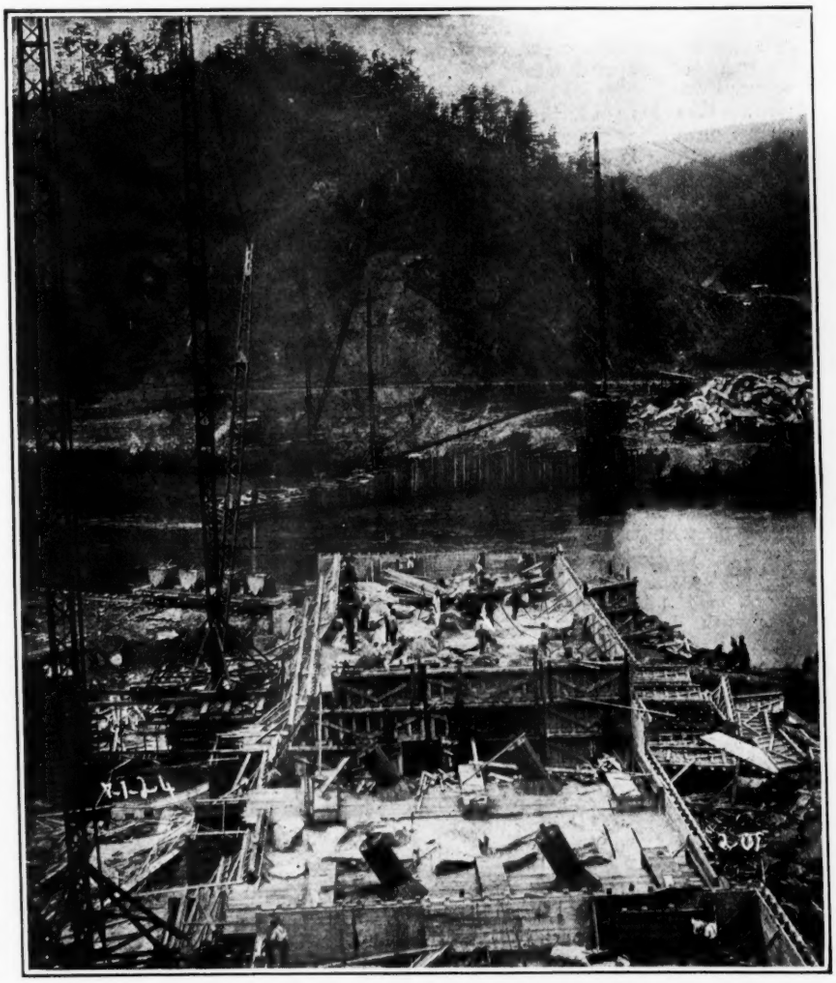
If the scheme is successful, other places such as the Romney marshes and the Medway, where the same conditions exist will be conducted at similar undertakings. The contract for the construction of the works has already been let and work started, according to recent press reports.

Yonah Dam on Tugalo River Progressing

The Yonah dam and power house, now being constructed by the Georgia Railway & Power Co., three miles below the great Tugalo dam, is the smallest of the water-power developments being carried out by this company in the Tallulah Falls regions of the North Georgia Mountains. It will form the last step in the chain, when all the projects are completed, by which the waters of the Tallulah, Chattooga and Tugalo Rivers will be used six times before finally being released to find their way to the sea.

The Yonah project, named after the highest peak in the surrounding foothills of the Blue Ridge Mountains, will consist of a dam 75 ft. high and 900 ft. long, which will back water up to the tailrace of the Tugalo plant.

A modern plant will be built just below the dam. Its generating equipment will consist of three 7,500-kw. vertical-type machines, direct-connected to 12,500-hp. waterwheels, operating under 75-ft. head. The plant will utilize all water passing the Tugalo plant from storage reservoirs on the Tallulah River and the partially regulated flow of the Chattooga River. The output is rated at approximately 70,000,000 kw.-hr. per annum.



View of Yonah Dam, Tugalo River, Georgia, in course of construction

Protests Chicago Diversion of Great Lakes' Waters

"The theft of lake water by Chicago must be stopped in some way," said George P. Graham, Minister of Railways and Canals, in an address to the directors of the Canadian National Exhibition, at a meeting held recently in Toronto.

"I am not saying that the United States is stealing water," Mr. Graham continued, "but the City of Chicago is. There is no treaty by which Chicago may take 10,000 ft. of lake water per second for its own purposes. Such a taking of water must result in the lowering of the lake levels and injury to our harbors and shipping."

The Minister said proposals had been made by the United States with regard to the St. Lawrence which he was not at liberty to disclose now.

"But I may say," he added, "that they are of vital importance to Ontario," according to reports in the daily papers.

Baker River Project Shows Progress

The Puget Sound Power & Light Co., Seattle, Wash., is pushing the construction on the Baker River development. The dam, which is to be built at a narrow gorge of the canyon, will be 245 ft. high, 180 ft. thick at the base and 400 ft. long on the crest, creating a reservoir of approximately 70,000 acre-feet.

The surface area of the artificial lake thus formed will be 1,780 acres. The Baker River is of glacial origin, having a fairly regular flow throughout the summer. In the fall, however, under the influence of the cool weather and before the rains set in, the flow falls off, and it is at this time of year that storage will be drawn upon for the 4,000 sec.-ft. required in the present development.

The main pressure tunnel, to carry the water of the reservoir to the penstocks, will be 24 ft. in diameter and 13,000 ft. long, lined with concrete, and of a capacity sufficient to furnish the total expected development of 80,000 hp. Gates and rack bars will control the input at the head of this tunnel and a surge tank will be installed near the lower end.

Two short steel penstocks from the lower end of the pressure tunnel, will connect with two 20,000-hp. waterwheels, of a make and design not yet determined, driving two 18,000-kva. 6,600-volt generators, likewise not specified as to make and design. The concrete power house will be laid out with the total possible future development in view.

Connection with the company's system will be made by a 110-kva. line 25 miles west to a 13,500-kva. substation at Sedro Woolley. From here the energy will be transmitted north 25 miles to Bellingham and south 45 miles to Everett, where a 27,000-kva. substation will be built.

The cost of the first development is estimated at $7,800,000. It is hoped to finish it in the fall of 1925.

St. Lawrence Study Not To Be Delayed by Disputes

No delay in the study of the St. Lawrence River is expected to result from the controversy that has arisen with Canada as to diversion. Secretary of Commerce Hoover says that he believes the study will go forward on the matters that are not in dispute. While they are being worked out, an understanding can be reached as to whether or not consideration is to be given the proportionate diversion going to each country at Niagara Falls. Canada would like to confine the discussion of diversion to that at Chicago.

Renewal in Canada of the suggestion that Canadian streams be diverted into the Great Lakes as a means of increasing their level has been noted with interest in this country. Some are of the opinion that Chicago well could afford to pay the cost of such diversion if the city thereby could be assured of authorization to use 10,000 sec.-ft. Objection to the plan has been raised in Chicago in the past on the ground that an amendment to the state constitution would be required before public funds could be expended in Canada. If for any reason it is not practicable to obtain an amendment to the constitution, it now is pointed out that the constitutional inhibition would not apply were the $10,000,000, the probable cost of the project, allowed Canada as payment for a claim.

Further evidence that the St. Lawrence study will not be delayed by difficulties arising in connection with the diversion controversy is had in the fact that Gen. Edgar Jadwin, Col. William Kelly and Col. George B. Pillsbury are meeting in Detroit to perfect plans in pursuit of the American portion of the investigation.

The extent to which Montreal coal dealers are pushing their campaign to render themselves independent of the American anthracite market is indicated by the fact that imports of Scottish coal this year will total 150,000 tons, compared with 75,000 last year.

Obituary

Arthur S. Huey, chairman of the board of directors of H. M. Byllesby & Co., died of pneumonia on Sept. 16, at the South Shore Country Club. He was ill for only a few days. Mr. Huey had been connected with the Byllesby organization as vice-president since it was founded in 1902, and had been in charge of its public utilities throughout the United States for many years. He was elected chairman of the board on May 6, 1924. Born in Minneapolis Aug. 17, 1862, and educated in the public schools there, he learned the trade of printer, which, however, he did not follow for long. Beginning in 1885, he represented the Edison Company (manufacturing) at Minneapolis. Seven years later he became identified with the Northwestern General Electric Co. at St. Paul and was for a long period in charge of that office. He leaves a widow, two sons and a daughter.

Water-Power Projects

Wendigo Falls To Have New Power Plant—A 6,000-hp. hydro-electric plant is being installed at Wendigo Falls by the Canadian Associated Goldfields in the Lardner Lake district of Ontario. It is expected that the machinery will be installed by the end of the year.

New Hiawassee River Project—The Thompson Power Co., of New York, has applied for a preliminary permit covering a project on the Hiawassee River. It is proposed to erect two dams 90 ft. in height and one slightly lower, so as to develop 259,000 hp. One of the dams will be in Turtletown Creek. The project is located in Poke County, Tennessee, and Cherokee County, North Carolina.

Aberdeen, Wash., Power Project.—A permanent injunction has been granted by a Washington court which is expected to block effectively the proposed municipal power project of the City of Aberdeen at a nearby site on the Wynooche River.

Conflicting applications covering this project are before the Federal Power Commission. In addition to the City of Aberdeen the Grays Harbor Light & Power Co., a Sanderson & Porter interest, has asked for a preliminary permit.

The effort of the municipal authorities in Aberdeen to develop the power project has been the cause of a bitter local controversy. The opposition to the municipal project comes largely from the property owners. They contend that a resolution calling for a bond issue of $2,000,000 was rushed through the city council. They claim further that this action was taken before the feasibility of the project was established and that the electorate gave the proposal a scant majority without knowing all the facts of the situation. It also is pointed out that the proposal had its main support among the non-property holders, many of whom are said to be affiliated with the I.W.W.

Personal Mention

Dad Green, of the Home Rubber Co., was the proudest man at the recent N.A.S.E. Convention. He has a three-weeks old grandduaghter.

Conway Pierce has resigned as boiler foreman with the Weirton Steel Co., Weirton, W. Va., to become associated with the Indianapolis Light & Heat Co., Indianapolis, Ind.

E. S. Cooley, formerly inspector of steam plants for the International Paper Co., has recently joined the West Virginia Pulp & Paper Co., 200 Fifth Ave., New York City, in the capacity of steam engineer.

John C. McCabe, formerly commissioner of the department of buildings and safety engineering and later research engineer for the City of Detroit, has associated himself with the Malcomson Coal Co., which offers its services to its patrons for the solution of their combustion difficulties and to secure minimum fuel consumption and maximum boiler efficiency.

Business Notes

The Charter Gas Engine Co., Sterling, Ill., announces the appointment of A. E. Park, 504 Randolph Bldg., Memphis, Tenn., to represent it in this territory.

The Triumph Electric Co., Cincinnati, Ohio, announces that Frank A. Wilch has been placed in charge of the Cleveland territory, succeeding Edward S. Ford.

The O. E. Frank Heater & Engineering Co. is the name of a company recently organized by Olive E. Frank, with offices at 80 W. Genesee St., Buffalo, N. Y., for heaters, coolers, condensers and heat exchangers.

The Superheater Co., 17 East 42d St., New York City, announces that B. N. Broido, who has been doing special consulting work for the company, has recently been appointed chief engineer of its industrial department.

The Consolidated Products Co., Inc., 15 Park Row, New York City, has recently purchased for resale the American Hominy Co. plant at Indianapolis, which includes a complete power plant of 2,500 hp., two generators, one of 1,000-kw. and the other 600-kw..

The Platt Iron Works, Dayton, Ohio, is the successor of the Stilwell-Bierce & Smith-Vaile Co., the latter company being the original makers of the pump which worked after being under water seventeen years, an account of which appeared in *Power* Aug. 26. The Platt Iron Works continues to build the Smith-Vaile pump.

Manning, Maxwell & Moore, Inc., New York City, announce changes: Percy M. Brotherhood, formerly vice-president, has been made consulting engineer; Frank J. Baumis, formerly works manager of the Putnam Manufacturing Co., Fitchburg, Mass., has been made vice-president in charge of the machinery department; Augustus Wood, formerly chief engineer of the Putnam Machine Co., has been made works manager.

The McClave-Brooks Co., Scranton, Pa., announces that its Southern district office, formerly located in Memphis, has been moved to Waco, Texas, with D. G. Counts as district manager. New Mexico, Colorado and Kansas have been added to this territory. A new district has been established at Nashville, Tenn. C. A. Parsons is district manager. This district will include Kentucky, Tennessee, Alabama and Mississippi. It is also announced that V. E. Holyoke has joined its New York district force and Erwin E. Hoffman, the Philadelphia office.

Trade Catalogs

Diesel Engines—The Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo., has issued a 95-page pamphlet dealing with its Diesel engines, both of the stationary and marine types. Unlike many such volumes this is not devoted exclusively to a discussion of machine details, but takes up the question of economics as applying to the generation cost with oil engines. Numerous illustrations of oil-engine plants assist in making the pamphlet both interesting and instructive.

Furnace Blocks—Bernitz Furnace Appliance Co., 177 State St., Boston, Mass. Bulletin B2, "Bernitz Clinker-Proof Super Blocks," gives illustrations, descriptions and stock sizes of this type of furnace lining.

Oil Engines — Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill. Pamphlet on oil engine applications, describing the "Y" type oil engines from 10 to 300 horsepower manufactured by this company. Illustrations showing the construction and operating features are included.

Station Control, Automatic—General Electric Co., Schenectady, N. Y. Bulletin No. 47731, "Automatic Station Control Equipment," besides describing the equipment and giving photos of installations gives a list of installations up to Jan. 1, 1924, which includes the name of the company, station, type of apparatus, kilowatt capacity and incoming and outgoing voltages.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution Washington, D. C. Meeting at Washington Dec. 29-Jan. 3, 1925.

American Ceramic Society. Ross C. Purdy, Lord Hall, Ohio State University, Columbus Ohio. Convention at Los Angeles, Calif., Oct. 6-7.

American Electric Railway Association. James W. Welsh, 8 West 40th St., New York City. Meeting at Atlantic City, Oct. 6-10.

American Electrochemical Society. Dr. Colvin G. Fink, Columbia University, New York City. General meeting at Detroit, Mich., Oct. 2-4.

American Institute of Chemical Engineers. Dr. John C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Annual meeting at Hotel Schenley, Pittsburgh, Pa., Dec. 3-6.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Fall convention at Pasadena, Calif., Oct. 13-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn meeting at Birmingham, Ala., Oct. 13-15.

American Society of Civil Engineers. 29 West 39th St., New York City. Fall meeting at Hotel Fuller, Detroit, Oct. 23-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 1-4.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at New York City, Dec. 1-3.

American Welding Society. Miss M. M. Kelly, 29 West 39th St., New York City. Convention in Cleveland, Oct. 30-31.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Eighteenth annual meeting at Hotel Chelsea, Atlantic City, N. J., Nov. 12-14.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Greenbriar, White Sulphur Springs, W. Va., Oct. 20-23.

Empire State Gas and Electric Association. C. H. B. Chapin, Grand Central Terminal Bldg., New York City. Convention at Lake Placid Club, N. Y., Oct. 6-7.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Que. Annual meeting at Montreal, Que., Jan. 27-29.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Briarcliff Lodge, Briarcliff Manor, N. Y., Oct. 27-31.

National Association of Practical Refrigerating Engineers. E. H. Fox, 5707 West Lake St., Chicago, Ill. Convention at New Orleans, La., Nov. 11-14. Exhibits at the Isaac Delgado High School.

National Exposition of Power and Mechanical Engineering. C. F. Roth, Grand Central Palace, New York City. Annual exposition at New York City, Grand Central Palace, Dec. 1-6.

National Safety Council. W. H. Cameron, 168 N. Michigan Ave., Chicago, Ill. Thirteenth Annual Safety Congress at Louisville, Ky., Sept. 29 to Oct. 3.

New England Water-Works Association. Frank T. Gifford, 715 Tremont Temple, Boston, Mass. Annual convention at Powers Hotel, Buffalo, N. Y., Sept. 23-26.

Society of Automotive Engineers. C. F. Clarkson, 29 West 39 St., New York City. Annual meeting at Detroit, Mich., Jan. 20-23.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at 29 West 39th St., New York City, Nov. 13-14.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Aug. 30, 1924	Sept. 8, 1924
Pool 1	New York	$2.90	$3.00
Smokeless	Columbus	2.15	2.15
Clearfield	Boston	2.35	2.35
Somerset	Boston	2.40	2.40
Kanawha	Columbus	1.55	1.55
Hocking	Columbus	1.65	1.65
Pittsburgh No. 8	Cleveland	1.85	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.85	1.85
S. E. Ky.	Louisville	1.75	1.75
Big Seam	Birmingham	2.00	2.00

FUEL OIL

New York—Sept. 17, light oil, tank-car lots; 28@34 deg. Baumé, 4⅜c. per gal.; 36@40 deg. 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Sept. 2, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.00 per bbl.; 26@28 deg., $1.00 per bbl.; 28@30 deg., $1.10 per bbl.; 30@32 deg., $1.20 per bbl.; 32@36 deg., gas oil, 4.8c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburgh—Sept. 9, f.o.b. local refinery; 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—Sept. 13, f.o.b. local refinery, 26@30 deg., $1.15 per bbl.

Philadelphia — Sept. 11, 28@30 deg., $1.99½@$2.06 per bbl.; 18@22 deg., $1.87½@$1.93¾; 13@16 deg., $1.75@$1.81½ per bbl.

Boston—Sept. 8, tank-car lots, f.o.b.; heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati — Sept. 8, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 4⅜c. per gal.; 26@30 deg., 4½c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Sept. 16, 20@22 deg., 5½c. per gal.; 24@26 deg., 6c. per gal.; 28@30 deg., 6c. per gal.

New Plant Construction

Ark., Little Rock—S. R. Morgan and F. L. Sherman, 212½ State St., have organized the Twin City Ice Co., and plans the construction of a 200-ton ice manufacturing plant, here, also a 40- to 80-ton plant in North Little Rock. Total estimated cost about $300,000.

Calif., Long Beach — Dedrick & Bobbe, Archts., Laughlin Bldg., are having preliminary plans made for the construction of 12 story stores and office building, estimated to cost $500,000. J. R. Mason, 219 East 1st St., is interested.

Calif., Los Angeles—F. A. Elliott, c/o Jonathan Club, Pacific Electric Bldg., are having plans prepared for the construction of a 12 story, 154 x 115 ft. hotel on 6th and Wilmer Sts. K. Macdonald, Jr. & Co., Brack-Shops Bldg., are architects.

Calif., Sacramento—The County awarded the contract for the construction of a laundry and power house, cost $70,624.

Conn., New London — The Onondaga Textile Mills, Inc., awarded the contract for the construction of a boiler house.

Conn., Waterbury—P. H. Carroll, East Aurora St., is having plans prepared for the construction of a 9 story, 60 x 185 ft. apartment on Prospect St., estimated to cost $500,000. W. E. Hunt, 187 Church St., Torrington, is architect.

Fla., St. Petersburg—Citizens Ice and Cold Storage Co. plans an addition to plant on Second Ave. and Tenth St., estimated to cost about $44,000.

Ga., La Grange — The Hillside Cotton Mills plans the construction of a central power plant, estimated to cost at least $40,000.

Ia., Cedar Rapids—The Killian Co., 210 Third Ave., will soon award the contract for the construction of a 12 story store and office building on 3rd Ave., and East 2nd St., estimated to cost $700,000. B. Rugh, Klinger Bldg., is architect.

Ky., Jackson—The Common Council is having plans prepared for the installation of electric operated pumping equipment at the proposed municipal water works. A. B. Hargis, Jellico, Tenn., is architect and engineer.

Ky., Pikesville — The City, J. Hatcher, Clk., will receive bids until Oct. 7, for a filter plant, pump station, pumps, reservoirs, etc. The J. N. Chester Engineers, Union Bank Building, Pittsburgh, Pa., are engineers.

Me., South Windham — The Windham Manufacturing Co. plans the construction of a boiler plant. Two boilers of 150 hp. each will be required.

Md., Baltimore—The Board of Awards, City Hall, will receive bids until Oct. 1, for furnishing and installing one 250 K.W. generating unit at Bay View Hospital. S. Purcell, City Hall, is engineer.

Mass., Cambridge — Barrington Court, Inc., c/o F. W. Norris and W. W. Hablitzell, Trustees, 31 Milk St., Boston, awarded the contract for the construction of a 7 story apartment to M. W. Ryan, 2 Central Sq. Estimated to cost $1,200,000.

Mich., Detroit—A. F. Herman, 710 Owen Bldg., Archt., is receiving bids for the construction of an 8 story, 100 x 183 ft. apartment including steam heating boiler and equipment on Second Ave., and Peterboro St., for A. Cohen, 2615 Woodward Ave.

Mich., Iron River — The Village, I. M. Miller, Clerk, will soon receive bids for 2,000 g.p.m. fire pump and a 440 v., 3 phase, 60 cycle slip ring motor. W. N. Gambrill is engineer.

Mich., Royal Oak — The City, P. H. Beauvais, Mgr., will receive bids until Sept. 29, for furnishing four motor driven centrifugal sewage pumping units and one motor driven sludge pumping unit. Hoad, Decker, Shorsraft & Drury, Ann Arbor, Mich., are engineers.

Miss., Marks—The City plans an election Sept. 30, to vote $35,000 bonds for waterworks and electric light plant equipment.

Mo., Charleston—The City is having preliminary plans prepared for a 100,000 gal. tank on tower, pumping equipment, etc. F. L. Wilcox, Chemical Bldg., St. Louis, is engineer.

Mo., Clinton—The City plans the construction of an electric light plant and distribution system. E. T. Archer and Co., New England Building, Kansas City are engineers.

N. H., Sunapee—New Hampshire Power Co. plans the construction of an addition to plant, estimated to cost $200,000.

N. J., Princeton — Day and Klauder, Franklin Bank Bldg, Archts., awarded the contract for the construction of a boiler house for Princeton University.

N. Y., Brooklyn — Chanin Construction Co., 105 Court St., plans the construction of a 26-story office building at 26 Court St., estimated to cost $4,000,000. Private plans.

N. Y., New York—Trustees Sailors Snug Harbor, 12 East 9th St., are having plans prepared for the construction of a 9 story apartment at 33-45 East 9th St., estimated to cost about $75,000. Helme and Corbett, 132 West 42nd St., are architects and engineers.

N. C., Rocky Mount—The Bd. of Aldermen and T. T. Thorne, Mayor, City Hall, will receive bids until Oct. 8, for the construction of a power plant building. W. C. Olsen, Raleigh, is consulting engineer.

O., Cleveland—The Ohio Bell Telephone Co., C. P. Cooper, mgr., 4300 Euclid Ave., are having preliminary plans made for the construction of a 20-story telephone exchange building on Huron Rd., estimated to cost $5,000,000. Hubbell & Benes, 4500 Euclid Ave., are architects.

O., Mariemont — Mariemont Co., Baker Court, Cincinnati, will soon award the contract for the construction of a heating plant on Wooster Pk., estimated to cost $150,000. J. Mirick, 1 Baker Court, is engineer.

Okla., Durant—W. H. Perkinson, Water Supt. and Comr., will purchase 2 boilers, 250 hp. each, super heater type.

Pa., Philadelphia — Norris Fruchtbaum, 6100 Spruce St., Engr., will receive bids for mechanical equipment for abbatoir including high pressure boiler, pumps, generator, motors, etc., for Duffy Bros., Front and Venango Sts.

R. I., Newport — A syndicate, H. A. Titus, Chn., c/o Chamber of Commerce, plans the construction of a hotel on Touro St., estimated to cost $500,000. Architect not selected.

R. I., Providence—Narragansett Electric Light Co. awarded the contract for the construction of a power plant and boiler house to D. E. McIntyre, Inc., Broad St., Boston, Mass. Estimated cost $2,500,000.

R. I., Providence — The Water Supply Board, B. Thomas Potter, Chn., will receive bids until Oct. 8th, for equipment for the purification works and portions of the Scituate aqueduct to include electrically driven centrifugal pumps and appurtenances. F. E. Winsor is chief engineer.

Tenn., Hohenwahl — The City plans an election to vote on $80,000 bonds for hydro-electric plant and municipal water plant. Engineer not selected.

Tex., Dallas — The City, M. G. James, Secy., will purchase 4 centrifugal motor driven sewage pumps.

Tex., San Antonio—San Antonio Hotel Co., L. J. Hart, Pres., Travis Bldg., plans the construction of a 12 or 14 story hotel on St. Marys and Travis St. Estimated cost $500,000.

Tex., Trinity—The City plans an election to vote $77,000 bonds for sewer system and waterworks, including well, reservoir, pump house, 300 gal. centrifugal pump, etc. F. J. Von Zuben, Ellison Blvd., Fort Worth, is engineer.

Wash., Tacoma—The Commissioners of Light and Water awarded the contract for the construction of the power house superstructure, service house, towers, etc., at Lake Cushman Dam to A. Gutherie & Co., 552 Sherlock Bldg., Portland, Ore. Cost $185,190.

Wis., Madison — Methodist Minister's Hospital Assn., J. W. Irish, Secy., 111 South Hamilton St., plans the construction of a hospital, estimated to cost, $1,000,000.

Wis., Milwaukee—H. Knuth, 1073 Teutonia Ave., is having plans prepared for the construction of a cold storage plant, estimated to cost $40,000. H. H. Bruns, 845 26th St., is architect. Refrigeration machinery will be required.

Wis., Milwaukee — Plankinton Arcade Co., 216 Plankinton Arcade, awarded the contract for the construction of 5 additional stories to Plankinton Arcade on Grand Ave., to S. M. Siesel Co., 160 Ogden Ave. Estimated cost $1,500,000.

Wis., Mushfield—Oconomowoc Canning Co., Oconomowoc, plans the construction of a cannery to include a powerhouse on South Central Ave, estimated to cost $60,000. Architect is not selected.

Ont., Brockville—Hydro Electric Power Commission will soon call for tenders for development of 2,500 hp. at Jones Falls, on the Rideau Canal.

Ont., Toronto—Dominion Tar and Chemical Co., Logan and Keating Sts., awarded the contract for the construction of a factory including a steam boiler plant. Estimated cost $200,000.

Que., Deschaillins — The City plans a waterworks system, including a pumping station, estimated to cost $15,000.

Que., St. Adele—Laurentian Hydro-Electric Ltd., plans to install new equipment.

Que., St. Gregoire—B. Ronleau, Mayor, plans the construction of an aqueduct and pumping station, estimated to cost $25.000.